F90

Barry's

RESEARCHES IN EMBRYOLOGY.

(Second Series.)

5480

The Author with much esteem
to his friend George Young

RESEARCHES

IN

E M B R Y O L O G Y.

(*Second Series.*)

BY

MARTIN BARRY, M.D. F.R.S.E.,
Fellow of the Royal College of Physicians in Edinburgh.

From the PHILOSOPHICAL TRANSACTIONS.—Part II. for 1839.

LONDON:

PRINTED BY R. AND J. E. TAYLOR, RED LION COURT, FLEET STREET.

1839.

Extract from the Report on the "Adjudication of the Medals of the Royal Society for the year 1839 *by the President and Council."*

"The ROYAL MEDAL in the department of Physiology, including the Natural History of Organized Beings, to MARTIN BARRY, M.D., for his papers entitled 'Researches in Embryology,' published in the Philosophical Transactions for 1838 and 1839."

XIX. *Researches in Embryology.—Second Series.* By Martin Barry, *M.D. F.R.S.E., Fellow of the Royal College of Physicians in Edinburgh. Communicated by* P. M. Roget, *M.D. Sec. R.S.*

Received March 28,—Read April 18, 1839.

In a former communication† I described the mammiferous ovum in its several periods of formation. The present paper is intended to trace it through the early stages of development.

What is known, or supposed to be known, of the evolution of the mammiferous ovum in its early stages, mainly rests on observations made, not in Mammals, but in Birds. Direct observations have been so few and so isolated, that between the time when the coitus takes place, and that of the incipient appearance of the vertebræ, there exists a dark period of which very little is really known. This hiatus it is one of the objects of the present paper to assist in filling up.

The ova of the Vertebrata generally were the subjects of investigation in my last memoir, it being then intended to demonstrate the essential identity in form, of certain structures which exist in the four classes of vertebrated animals. The ovum as then considered was in a state of comparative, though not entire, repose. The present series of researches, on the contrary, investigates the ovum while undergoing rapid changes. In order the more completely to watch the progress of these changes, it seemed desirable to confine the attention to a single species. The one I selected was the Rabbit, to which animal all general remarks made in this paper will refer‡.

For the illustration of a subject like the present, which may be compared to a series of metamorphoses, it will be obvious that we ought to be in possession of a *suite* of stages. These I trust have been obtained, though not without difficulties at times in the highest degree discouraging and inseparable from the very nature of the subject,—difficulties felt by De Graaf, Cruikshank, Haighton, Prevost and Dumas, Baer, and others. But there existed other difficulties, the best evidence of which is the result, that I am compelled, however reluctantly, to call in question some views which were considered to be settled; and these embracing points of cardinal importance. For example, according to my observations the embryo does not arise in the substance of a membrane.

The discrepancies to be found in the accounts of authors on the ovum of Mam-

† Researches in Embryology, First Series. Philosophical Transactions, 1838, Part II. p. 301.

‡ Among the figures will be found several from the Tiger, for an ovary of which animal I am indebted to the kindness of Professor Owen.

malia, and the confused nomenclature of its membranes, appear referable to the absence of early observations in continuous succession. Observers have not directed their attention to the ovum *post coitum* before it leaves the ovary; and they cannot be said to have thoroughly examined it in the Fallopian tube. Now so rapid are the changes which the ovum undergoes at the period in question, that had I not very often seen it in both of those localities, it would have been impossible for me at least to understand it in the uterus. And in proof that others failed to do so, it may be stated that ova of the Dog measuring half a line, have been described by eminent observers as consisting of a single membrane; whereas in the Rabbit, according to my observations, ova of still minuter size may consist of four membranes in addition to the embryo, (one of these membranes being composed of two laminæ); to which it may be added, that I find one membrane to disappear by liquefaction within the ovum while the latter is in the Fallopian tube.

From what has been stated, it will be obvious that in undertaking researches in so difficult a subject as that of embryology, the mind should not be pre-occupied with any theory. I certainly had none to establish. If I was at all prepossessed, it was in favour of existing doctrines; and it has been in spite of such prepossession that fact after fact has gradually but irresistibly compelled me to form other views. In the following pages there will be found no speculations, as I have confined myself to a simple delineation of appearances, and to the most obvious conclusions arising from them. If in any points I have been mistaken, that indulgence will, I trust, be accorded which may be fairly claimed in exploring one of the most hidden regions of physiology. That in the main facts I have not erred seems probable, from the repeated opportunities afforded for their confirmation. The number of Rabbits examined considerably exceeds a hundred, and I have recorded in my notes the particular results regarding eighty-nine. Besides ova that were still present in the ovary and apparently destined to escape, ninety-three have been found in the Fallopian tube, and two hundred and thirty-six in the uterus. I have kept a separate record of the measurements and other particulars of most of these. Tables will be given (par. 319.), showing the diameter, general condition, and locality, of two hundred and fifty-six of the minuter of these ova, very few of which exceeded in diameter half a Paris line, and by far the greater number were considerably below this size, some indeed not exceeding $\frac{1}{14}$th and even $\frac{1}{15}$th of a Paris line. Of these ova I have preserved sixty-six. The foregoing will serve to show that my conclusions have not been drawn from solitary facts or isolated observations†.

† The following testimony to the importance of the history of development, is from the pen of an eminent observer, (E. Huschke, in Meckel's Archiv, vol. vi. p. 1.) "Systematic physiology rests especially on it, and can never rapidly advance unless it becomes more perfect, for this it is which gives to the philosopher the material wherewith to rear a solid fabric of organic life. Hence in anatomy and physiology, our endeavours ought more than is now the case to have reference to it; in other words, we should constantly examine not only every organ, but every material, and also every action, with the inquiry, *how did they originate?*"

(The measurements throughout this paper, as in the former one, are stated in fractions of a Paris line, and thus expressed ($'''$). As a simple mode of reducing this fraction into (what is very nearly) the equivalent fraction of an English inch, I recommend multiplying the denominator of the former by $11\frac{1}{4}$. See the "Table of Measurements" (par. 320.). The actual sizes of some of the ova are represented at the foot of Plates VI. and VII.

The Mature and the Immature Ovum.

120. The difference perceptible between ova in these two states appears to me to consist in the condition of the yelk. In the immature ovum the yelk contains separate oil-like† globules, diffused in a fluid (Plate V. fig. 85. *d*); while in the ovum that is mature, the yelk presents a peripheral stratum, sometimes appearing granulous, and at others seeming to consist of vesicles pressed together into a polyhedral form, its centre being in the state of fluid.

121. The globules of the yelk just mentioned as oil-like in their appearance in the immature ovum (fig. 85. *d*), are in reality vesicles. In fig. 87. are some of those vesicles from an immature ovum of the Tiger, in which animal I found them exceedingly distinct. But besides being true vesicles, those globules contain objects which themselves are also vesicles; the latter in some instances presenting opacities in their interior, and they are often observed to be pressed into an irregular shape‡.

122. The globules contained in the vesicles ("cells") represented by Dr. Schwann § from the yelk-cavity of a Hen's egg do not exhibit the appearance of vesicles so decidedly as the above. In the Cat, however, I have found the vesicles of the yelk to contain a globule very much resembling that just referred to as figured by Schwann, yet the outer vesicles had the same high refracting power as those from the Tiger (Pl. V. fig. 87.), and in this respect, therefore, differed from those in the figure by Schwann. Is the difference referable to a difference in age‖?

Effects produced on the Ovum in the Ovary by Maceration.

123. On a former occasion (*l. c.* par. 50.) I referred to the effects of maceration, as increasing the probability that a proper membrane of the yelk existed generally in the class Mammalia; for it was shown that although the thick transparent membrane of the ovum or "zona pellucida" (*f*) by imbibition had become distended, the yelk-

† The term "*oil-like*" is used, as in my former memoir, to describe simply the appearance and not the nature of the globules to which it is applied.

‡ It is an interesting fact, as several figures in my "First Series" (*l. c.* Plate V. figs. 14, 15, 16,*) serve to show, that the yelk-globules (vesicles) collect, and perhaps originate, around *the germinal vesicle.*

§ Mikroskopische Untersuchungen über die Uebereinstimmungen in der Struktur und dem Wachsthum der Thiere und Pflanzen. Tab. II. fig. 2. Berlin, 1838–9.

‖ Perhaps, however, it is the globules of the "*discus vitellinus*" rather than those of the yelk-cavity in the egg of the Bird, with which the globules of the substance usually called the yelk in the mammiferous ovarian ovum are to be compared (par. 174. first Note. par. 318.).

ball still retained its size and form. In the present paper, Plate V. fig. 88. affords a proof of this in an ovum of the Tiger. Here, however, in addition to the yelk continuing spherical, its proper membrane (*e*) was very distinctly visible.

124. The most conspicuous change produced by maceration is distention of the membrane *f*, but I have observed the germinal vesicle also before disappearing to become elliptical. See the figure just referred to and also fig. 89., which exhibits the germinal vesicle (*c*) of the same ovum on a larger scale. From the germinal spot (*b*) in this instance there were seen to have arisen three membranes or vesicles, its central part consisting of a fourth, which appeared to contain a pellucid fluid. Between these membranes or vesicles of the former spot, were granules and a fluid (par. 298.) the granules being situated for the most part near the centre.

The Rut.

125. It is known that at this period there occurs increased vascularity of the parts in general, and of certain Graafian vesicles in particular. I have found that the number of Graafian vesicles appearing to become prepared, by enlargement and vascularity, for discharging their ova, exceeds the number of those that actually discharge them (par. 126.). The fluid of the Graafian vesicles in general which are situated at the surface of the ovary, is more viscid now than at other seasons. The degree of this viscidity, however, as well as the condition of the yelk, seems to depend on the degree of advancement of the period in question. In ova taken from enlarged and vascular Graafian vesicles, the germinal vesicle is at the periphery, and the yelk mature (par. 120.). I have also in some instances observed the peripheral stratum of the yelk to have become more finely granulous than in usual states of the mature ovum *ante coitum*. The changes in the tunica granulosa and retinacula, incipient perhaps at this period, will be more particularly mentioned among those referable to the coitus.

The Ovum in the Ovary post coitum†.—*First and Second Stages of Development.*

126. I have found it extremely difficult to distinguish with precision between the changes referable to the rut, and the further changes resulting from the coitus. For reasons given in the introduction to this memoir, it did not seem sufficient to see the state of ova first in the Fallopian tube. But then it was equally unsatisfactory to examine ova still in the ovary; for at first I was not in possession of any means of distinguishing those that were really destined to be discharged, as in addition to the Graafian vesicles, from which ova would have been expelled, I have (as already stated)

† As researches of this kind would be impossible, or the results of no value, without the means of determining precisely the period between the coitus and the death of the animal, I shall be excused if I mention for the professional reader, 1. That persons were employed who might be relied upon, and were fully competent to judge of the condition of the female rabbit in reference to the rut: 2. That the coitus was in every instance *seen*, and the time as well as the degree of readiness for the reception of the male particularly noticed and recorded; and 3. That immediately after the coitus the female Rabbit was removed and kept separate from the male.

generally found several others that had become enlarged and vascular (par. 125.). It therefore was an object of great interest to meet with ova that were on the point of entering the tube.

127. The periods of 4, 6, 8, and $8\frac{1}{2}$ hours *post coitum*, were found too short, the ova being still within the ovary, and apparently not very near the time of their expulsion. A rabbit was examined at eleven hours, when the ova were found to have made their exit from that organ; and one at ten hours, with the same result. Another was killed at nine hours; the ova were still within the ovary, and their Graafian vesicles presented no decided indication of an approaching rupture. I tried $9\frac{1}{4}$ hours, when the ova were again found within the ovary; while in another instance at nine hours they had escaped. This was discouraging, but it seemed worth while to persevere. At length, after nearly a score of rabbits had been devoted to anatomical inspection, for the single object of determining the condition in which the ovum leaves the ovary, the parts were found in a state precisely what I had so much desired to meet with; one of these animals at ten hours yielding me two ova that had left the ovary and advanced an inch into the tube, and two others that were still in the ovary, but beyond all doubt on the point of following them.

128. According to my observations, then, ova of the Rabbit destined to be developed are frequently discharged from the ovary in the course of nine or ten hours *post coitum*. Burdach† refers to only one authority on this subject, stating that Cruikshank saw the Graafian vesicles of the Rabbit to burst in the short period of two hours. From Cruikshank's paper‡, however, it appears that this was observed in a single instance only. Kuhlemann§ found Graafian vesicles of the Sheep to have burst at the end of the first day; and Hausmann‖ observed that in the Hog they had nearly all burst in seventeen hours. The conclusions of Prevost and Dumas¶ as to the time of bursting of the Graafian vesicles in Dogs, appear to rest chiefly on the period when those observers found ova in the uterus, from which nothing can be determined as to when they left the ovary. I have recorded in my notes several instances in which, after a much longer period than nine or ten hours, the ova (in the Rabbit) had not escaped. But in those instances there was no proof that any ova were destined to escape,—in other words, that the coitus had been productive. Still, however, the condition of the animal, and more particularly the degree of its advancement in the rut, probably occasion considerable differences in this respect. Yet I am satisfied that ova very frequently leave the ovary in nine or ten hours; to have determined which, it will be hereafter seen (par. 166.) is a point of some importance.

129. Several observers appear to have supposed the ova to be still present in the ovary after their escape. Cruikshank††, for instance, mentions a little body which he found on the top of the *corpus luteum* three days *post coitum*. That little body he

† Die Physiologie als Erfahrungs Wissenschaft, vol. ii. p. 12.

‡ Philosophical Transactions, 1797.

§ Burdach, *l. c.* vol. ii. p. 12.

‖ Ibid. vol. i. p. 555.

¶ Froriep's Notizen, No. 189, p. 198.

†† *L. c.* p. 206.

supposed to be the ovum. What it really was I shall endeavour hereafter to render probable (par. 155.); but it is very unlikely to have been an ovum.

130. It appears from the observations just made known (par. 127.), that in the Rabbit all the ova of one impregnation are discharged at about the same time. This is opposed to the opinion of Prevost and Dumas†, that in the Rabbit at least two days elapse before all the ova destined to be developed have left the ovary. That I am correct in this particular, is rendered still more probable by the fact, that in the Fallopian tube, and in the beginning of the uterus, minute ova are generally (though not in every instance) met with lying very near together‡. Having found more than three hundred ova in the uterus and tube, I may perhaps venture to speak with some confidence as to their particular localities, which it has uniformly been my practice to record. A general idea of the situation in which many of the minuter ova have been observed, may be obtained from the Tables (par. 319.).

131. If my endeavours to obtain ova when just on the point of entering the tube were for a long while fruitless, unexpected facts were noticed, amply repaying all the labour. It was in the course of those wearisome endeavours, that the germinal vesicle first presented itself in situations which made me doubt its disappearing at the period hitherto supposed. I saw it in mature ova half-way between the surface and the centre of the yelk,—a locality which was remarkable from the fact, that *ante coitum*, and even while the ovum is yet immature, the germinal vesicle is seen to have passed to the surface of the yelk. Now such a situation of the germinal vesicle would probably have escaped my attention, if the observation had not been many times repeated. Yet on a knowledge of the fact that the germinal vesicle returns to the centre of the yelk, depends the possibility of fully understanding the ovum in some of its future phases.

132. I shall now describe the changes apparently resulting from sexual connexion, observed in the ovum of the Rabbit while still within the ovary. Some minute details will be unavoidable, but so far as is consistent with perspicuity I shall endeavour to be brief.

133. After some hours the germinal vesicle is found to have left its situation at the surface of the yelk and to be *returning to its centre*, from whence it came. About the same time I have observed to have arisen from the surface of the germinal spot a membrane—that is, a vesicle—which speedily enlarged so as to apply itself to the inner surface of the germinal vesicle. The vesicle thus proceeding from the spot, of course imbibed the fluid of the germinal vesicle, which in its new situation appeared finely granulous, and yellowish-brown in colour. The germinal vesicle having now two membranes, was less transparent, and less easily ruptured than before; and I have

† *L. c.* No. 189, p. 199.

‡ It is an interesting fact, that if a larger number of ova than usual escape from one ovary, a proportionally smaller number is discharged from the other.

observed what appeared to be the further effect of this additional membrane, in the vesicle remaining visible, casting a shadow, and even not at all collapsing after being ruptured (Plate V. fig. 92.).

134. The germinal spot, previously on the internal surface of the germinal vesicle, is soon observed to occupy its centre; presenting thus the same change in relation to the germinal vesicle, as the latter undergoes in reference to the yelk-ball. The spot becomes very much enlarged, and in its centre there is now a pellucid point.

135. On some occasions, when the germinal vesicle was observed to be returning from the surface to the centre of the yelk, the yelk viewed with reflected light exhibited the appearance of masses, between which there was a pellucid fluid. At other times I have seen with great distinctness a cavity in the centre of the yelk. Plate V. fig. 93. shows the germinal vesicle (*c*) just entering such a cavity. This figure represents a stratum, apparently of vesicles, forming the periphery of the yelk. Subsequently this stratum has disappeared (the proper membrane of the yelk having in the mean time thickened), and the yelk has become fluid at its surface; while its central portion, in which the germinal vesicle now lies, has become obscure. In a stage still later more of the yelk has liquefied, and in the liquid are granules, the central part of the yelk having now an ellipsoidal form (Plate V. figs. 96. and 97.).

136. The proper membrane of the yelk was shown in my "First Series" (*l. c.* Plate VIII. fig. 70. *e.*) to be present at an early period in the existence of the ovum, but stated to be from its tenuity in Mammalia generally invisible. At the period at present under consideration it suddenly thickens, highly refracting light (Plate V. figs. 94. 96. 97. *e.*), and is often reddish-brown in colour. This thickening of the proper membrane of the yelk is not among the earliest of the changes resulting from sexual connexion, but follows those above described, and for the most part takes place immediately before the discharge of the ovum from the ovary. The stratum of vesicles referred to in the preceding paragraph (fig. 93.) has now disappeared.

137. The thick transparent membrane of the ovum, or "zona pellucida" (*f*), begins to imbibe fluid and distend, so that a minute space, filled with fluid, is visible between it and the yelk-ball (Plate V. figs. 96. and 97. *e.* and *f.*). This change follows the incipient thickening of the proper membrane of the yelk (*e*), and in some instances is not appreciable until after the ovum has made its exit from the ovary.

138. The tunica granulosa (Plate V. figs. 93. 96. 97. g^1.) was shown on a former occasion (*l. c.* par. 64–71. 88.) to be at first a spherical and subsequently a flattened accumulation, on the ovum, of the peculiar granules, or rather vesicles of the ovisac. At the period in question its vesicles hang less tenaciously together, and frequently appear to be passing into a fluid state. The tail-like appendages, as I have called them, of this tunic are now very distinctly seen to be continued into the four persistent retinacula, evidently contributing themselves to perform the same offices (par. 149—151.) as the latter (fig. 96. g^1.).

139. The retinacula (Plate V. figs. 93. 96. g^2.) (described in my "First Series"), at the period now before us, become enlarged, for which there seems to be a provision

ante coitum in the wrinkled state (as formerly mentioned, *l. c.* par. 86. *Note.*) of their investing membrane. In some instances I have observed a number of minute dark globules to be mixed with the vesicles which form these structures. Sometimes, as in fig. 96. g^2., the retinacula, beginning to liquefy, resemble a collection of pellucid drops of fluid.

140. Most of the changes now mentioned I have found to take place before the ovum leaves the ovary. Yet certain of the later ones in some instances are not observable until the ovum has passed into the Fallopian tube. From my observations, therefore, it appears that there is no condition of the ovum uniform in all respects, which can be pointed out as that in which it is expelled; though the same observations lead me to conclude that Plate V. figs. 96. and 97. present a state which is frequent when the discharge takes place, viz. the germinal spot (*b*) has a central pellucid point; it is situated in the centre of the germinal vesicle (*c*); the latter has a dark contour, and perhaps a double membrane; around it is an ellipsoidal mass; the yelk (*d*) is a fluid containing granules; the proper membrane of the yelk (*e*) has thickened, highly refracts light, and is often reddish-brown in colour; there is a minute space, filled with a transparent and colourless fluid, between this membrane and the membrane *f*; and finally the tunica granulosa (g^1) and retinacula (g^2) present the appearance of incipient liquefaction.

141. A synopsis in my former memoir exhibited seven successive stages in the *formation* of the ovum (par. 292. *Note.*). In the present paper also, it will be convenient to adopt the same plan of considering the ovum in successive stages. These, however, occurring *post coitum*, will be stages of *development*. I propose to consider as the first stage, that represented in Plate V. fig. 93; and as the second stage, the condition which is frequent when the ovum leaves the ovary (figs. 96. and 97.).

142. To obtain these facts, and have it in my power to state them with any degree of confidence, and in the order of their occurrence, has been an undertaking of no common difficulty; and there did not exist, so far as I could discover, any recorded observations belonging to this period that might be taken as a guide.

Locality in which the Ovum is fecundated.

143. As to the particular locality in which the ovum becomes susceptible of development, physiologists are not agreed. Some maintain that it acquires this susceptibility before it leaves the ovary; others that the change is not effected until after its expulsion from that organ.

144. It is not my purpose to discuss the question whether contact of the seminal fluid with the ovum is or is not essential to impregnation. Yet perhaps it may be proper for a moment to refer to the possibility of that contact while the ovum is still within the ovary, this having been denied.

145. Prevost and Dumas † maintain that the Spermatozoa do not penetrate so far as to the ovary, and conclude that in all Mammals impregnation takes place in the horns of the uterus. I do not doubt that the observations of Prevost and Dumas were accurate, for in seventeen out of nineteen instances in the Rabbit, though the parts were generally examined while still warm, I was unable to discover Spermatozoa in the fluid collected from the surface of the ovary. In the other two instances, however, Spermatozoa, or at least animalcules exactly like those I had been accustomed to meet with in the uterus and vagina, were really found on the ovary. I should rather say, that on one of those occasions Spermatozoa were seen, while on the other it was a single Spermatozoon that was observed. Some of the former were alive and active, though not in *loco*motion; others were dead. In that case, twenty-four hours *post coitum*, there was neither enlargement of the Graafian vesicles nor a high degree of vascularity in any of the parts. In the other instance the single Spermatozoon found was dead, and the ova had escaped. Now whether the Spermatozoa are essential to the impregnating power of the seminal fluid, I do not think it needful to inquire. The fact that in the course of these researches they have been met with on the ovary, demonstrates that the seminal fluid sometimes penetrates as far as to the surface of that organ. Whether it penetrates into its interior I am unable to determine; but certainly the changes above described, as taking place *post coitum*, in the condition of the ovum while still within the ovary, are too remarkable not to favour the supposition that it does ‡.

146. The changes now more especially referred to will presently be seen. The germinal vesicle *ante coitum*, after the formation of the yelk has begun, is situated in the centre of the latter. From that locality it passes to the surface of the yelk, the germinal spot being situated on the internal surface of the germinal vesicle. The ovum (as shown on a former occasion, *l. c.* par. 85.) is conveyed from the centre to the surface of the Graafian vesicle, and indeed to that part of the surface which is situated nearest to the exterior of the ovary §, being determinately held by the retinacula in this situation ||. The proper membrane of the yelk is hitherto extremely thin. Such is the condition of the mature ovum *ante coitum*; that is to say, its essential parts lie as *near* as possible to the surface of the ovum. *Post coitum*, before the discharge of the

† *L. c.*, No. 189, p. 199.

‡ Since the above memoir was presented to the Royal Society I have learnt that Professor Bischoff, of Heidelberg, had previously found Spermatozoa on the ovary of another Mammal, the Dog (par. 278.).

§ In repeated instances also I have found the germinal vesicle at that part of the surface of the yelk which was situated nearest to the periphery of the Graafian vesicle, and therefore as near as possible to the surface of the ovary. This accords with the observations of R. Wagner, that in *Dytiscus marginalis*, and in some other insects, the germinal vesicle always appears on that side of the ovarian tubes which is directed towards the cavity of the abdomen. Thus in a bunch of ovarian tubes the vesicle is never situated at that part where the tubes lie one upon another. (Beiträge zur Geschichte der Zeugung und Entwickelung, p. 46.)

|| R. Wagner suggested that the "disc" (my tunica granulosa and retinacula) might serve to hold the ovum at the surface of the Graafian vesicle, and thus promote impregnation. (Beiträge, &c., p. 39.)

ovum from the ovary, the germinal spot passes to the centre of the germinal vesicle, and the germinal vesicle returns to the centre of the yelk. The proper membrane of the yelk suddenly becomes thickened.

147. Such alterations suggest the probability of some sudden and important change having been effected in the condition of the ovum; and moreover, that which is allowed to be its most essential part, previously as *near* as possible to the surface of the ovum, is now withdrawn as *far* as possible from that surface, by being once more removed to its centre. Nor is it to be forgotten that the proper membrane of the yelk, previously extremely *thin*, has suddenly thickened. These changes, which I have no doubt will be confirmed by future observers, render it highly probable that the ovum has undergone fecundation. The nature of the changes is such as to favour the supposition that they are produced by contact of the seminal fluid with the ovum; and we have seen them to take place within the ovary. I therefore suppose the ovary to be the usual locality in which the ovum is fecundated. Still, however, as we have reason to believe that the ovary, in some animals at least, discharges ova which are not fecundated †, this change may perhaps in some instances take place in the oviduct.

Discharge of the Ovum from the Ovary.

148. This appears to be effected in part at least, as supposed by Valentin, through the operation of a *vis a tergo*, the latter being produced by the exuberant growth of a reddish fleshy mass, which acts through the medium of the fluid of the Graafian vesicle. The particular structure originating that fleshy mass, I shall have occasion to refer to in connexion with the *corpus luteum* (par. 156.).

149. When describing in my "First Series" (*l. c.* par. 80–91.) the offices of the retinaeula (Plate V. figs. 85, 86, 93, 96. g^2.), I stated that they appeared first to support the ovum in the centre of the Graafian vesicle, next to convey it to the periphery of that vesicle, and subsequently to retain it in the latter situation,—probably contributing also to attenuate the parietes of the vesicle at a certain part, so as to promote the expulsion of the ovum from the ovary. It remains to notice some other offices apparently performed by these structures.

150. It is the central portion of the retinacula, and not the minute ovum, that presents a surface for the operation of a *vis a tergo*. The retinacula therefore escape with the ovum (Plate V. fig. 96. g^2.); and by their long bands, and the connexion of those bands with the membrana granulosa, render the escape of that important body gradual. They also seem to afford a considerable surface for the operation of

† Haighton showed that corpora lutea formed in both ovaries, although the access of the seminal fluid on one side had been made nearly impossible by obliteration of the tube *ante coitum*. Fœtuses, however, were present only on the unmutilated side. Philosophical Transactions, 1797. Dr. Blundell went farther, obliterating the upper part of the *vagina*, *ante coitum*, and found that the coitus produced corpora lutea but no fœtuses. But we know that even sexual connexion is not necessary for the production of corpora lutea. See some excellent remarks on this subject by Dr. Allen Thomson, article "Generation," in Dr. Todd's Cyclopædia of Anatomy and Physiology, pp. 465, 466.

those means by which the minute ovum is made to enter the Fallopian tube. And finally, enlarged and in a half fluid state, they appear to be the bearers from the ovary of a substance for the immediate imbibition of the ovum, and probably enter into the formation of the chorion.

151. The tunica granulosa (Plate V. fig. 96. g^1.) appears to assist in all of these offices, and especially in the two last named†.

The Corpus luteum.

152. When the discharge of the ovum from the ovary is very near, that portion of the Graafian vesicle directed outwards is seen to have been removed, so that little or nothing remains to obstruct the passage of the ovum besides the peritoneum. The peritoneum therefore appears to me to be the part that gives way last.

153. If a Graafian vesicle about to discharge its ovum be carefully dissected out of the ovarium, and so placed that the compressor may act upon it laterally, an appearance is obtained which I have represented in Plate V. fig. 95. This on a larger scale, and after the object has been ruptured by compression, is exhibited in fig. 96. Here *h* is the vesicle, which in my former memoir (*l. c.* par. 1–5. 25.) I described as the true and originally independent *ovisac*; *i* is the covering gradually acquired by the ovisac; the union of the two—according to my observations—forming the so-called Graafian vesicle. At the period now under consideration the covering (*i*) has become a thick and highly vascular mass; and with this change in its covering the ovisac itself has lost considerably in the size to which it had been distended.

154. A few hours after the ovum has been discharged, if lateral pressure be applied, there escapes from the thick and vascular mass (*i*) a minute translucent body (Plate V. fig. 98.), perfectly spherical in form, and having a diameter of less than half a line. This, placed under the microscope, is found to be the *ovisac*, thus easily removed from its covering. In the substance of the latter it will be remembered lie the vessels. The ovisac itself presents no trace of any, though in some instances its substance has seemed to be pervaded by pellucid points. At a certain part of it (see the figure) is the orifice by which the ovum was expelled, its margin bloody. I have found that orifice in several instances to be elliptical, and to measure from $\frac{1}{4}'''$ to $\frac{2}{5}'''$ in length.

155. Several days after the ovum has escaped, there is protruded from the centre of what was formerly the Graafian vesicle, a mammillary process, noticed by several observers, very accurately figured by De Graaf, apparently mistaken by Cruikshank‡ for the ovum (par. 129.), and not inappropriately compared to a sort of hernia by Coste. The primitive ovisac is at this later period no longer met with in the ovary§,

† Von Baer mentions that in the Dog the "disc" passes with the ovum into the Fallopian tube. (Lettre sur la Formation de l'Œuf dans l'Espèce humaine et dans les Mammifères, Commentaire, p. 40.)

‡ *L. c.*, p. 206, third day after the coitus, Experiment xviii. "The pouting part I believe is the ovum, and stands upon the top of corpus luteum. It is very vascular, particularly at its basis." See also Experiment xxiv.

§ Whether in the interim the ovisac has been absorbed *in situ* or first expelled, I do not know. In the Hog I have found what seemed the remains of ovisacs in the infundibulum.

for the mammillary process appears to consist solely of an inverted portion of the vascular and spongy substance which previously constituted the covering of the ovisac.

156. The obvious conclusion from these observations is, that *the covering of the ovisac* (Plate V. figs. 95 and 96. *i.*) *becomes the corpus luteum.*

157. In making this assertion I am so unfortunate as to find myself again expressing an opinion at variance with that of BAER. I have no doubt that the *corpus luteum* forms in the structure where he exhibits it†; but that structure, I must respectfully maintain, is not, as he calls it, the inner membrane of the Graafian vesicle; for that inner membrane is constituted by the ovisac, which disappears. Dr. POCKELS‡ has figured three membranes as entering into the formation of an advanced Graafian vesicle, besides the membrana granulosa; and it appears to me that what he has termed the "Nucleus," "Ovum Graafianum," and "Folliculus," is my *ovisac*,—a structure which it will be remembered was in my former paper followed upwards from the minuteness, in some instances, of $\frac{1}{100}$dth of a line. And it farther appears to me to be this same vesicle (the ovisac) that Dr. POCKELS refers to in the Sheep and Goat, as remaining in the incipient *corpus luteum* eight days and more after the expulsion of the ovum from the ovary§. VALENTIN|| has very accurately shown the appearance of the *substance* of the *corpus luteum* on a small scale.

Disappearance of Ova post coitum.

158. During the rut, as already mentioned, several Graafian vesicles seem to be prepared by enlargement and vascularity for discharging their contents, besides those from which ova are actually expelled; so that for some hours even *post coitum* it is not easy to distinguish the latter from the former. After the ova have been discharged, therefore, the ovary often presents several Graafian vesicles, which are enlarged and highly vascular. These, as well indeed as many of the minuter ones, seem to be absorbed; and during several stages of that process appearances occur which it may be worth while to mention, as from their resemblance to some of the changes produced by impregnation, they are calculated to mislead.

159. The yelk liquefies. This change is first seen *around the germinal vesicle* (Plate V. figs. 99 and 100.), in which situation also it will be remembered the yelk-globules (vesicles) present their first appearance (par. 121. *Note.*). The germinal

† Lettre, &c., fig. xiv.

‡ MÜLLER's Archiv, 1836, Heft II. Tab. VI.

§ *L. c.*, p. 203. I am inclined to think that the membrane which, in some instances, is found lining the cavity (when a cavity exists) in the corpus luteum, is no other than the originally independent vesicle called by me the "ovisac." See Figures of the corpus luteum in the human female by Dr. MONTGOMERY (Exposition of the Signs and Symptoms of Pregnancy, &c., 1837.), who has very justly stated that it is not the inner membrane of the Graafian vesicle that becomes the corpus luteum.

|| Dissertation by BERNHARDT, "Symbolæ ad Ovi Mammalium Historiam ante Prægnationem." Vratislaviæ, 1834, fig. xxx.

vesicle collapses, generally becomes elliptical, and more or less thickened (fig. 101. *c.*). The germinal spot appears breaking up, and in its centre is sometimes seen a dark point (fig. 101. *b.*). The "zona pellucida" becomes elliptical, thin, and very much distended (figs. 100, 101. *f.*). The tunica granulosa and retinacula liquefy, leaving the ovum uncovered, or with a few dark globules on its surface (figs. 99 and 100.).

160. Such are the changes observed when absorption is commencing *post coitum.* It will be seen that in some respects they resemble the earliest effects of impregnation, but differ from them in the following; viz. the germinal vesicle does not return to the centre of the yelk; the proper membrane of the yelk does not thicken, and is not even visible; and when the "zona pellucida" is distended, the imbibed fluid mixes with the yelk. The above changes also differ from those described in my "First Series" (*l. c.* par. 60. and Plate VIII. fig. 67.) as accompanying the absorption of ova *ante coitum,* in the condition of the yelk. The yelk was then described as nearly black, from myriads of minute granules and oil-like globules; while in ova absorbed *post coitum* the yelk seems to pass immediately into the state of a colourless and pellucid fluid, whether those ova are mature or immature; for I have met with some ova undergoing absorption at this period, which were exceedingly minute.

Graafian Vesicles containing Blood in their Interior.

161. After the impregnated ova have been discharged from the ovary, some of the larger Graafian vesicles, remaining unbroken, are frequently found to contain a considerable quantity of dark blood, which gives them the appearance of blackish spots. Such spots have been noticed by several authors, who supposed them to indicate the Graafian vesicles from which ova were destined to be expelled. It is not unusual, however, to find Graafian vesicles thus filled with blood in cases where the escaped ova, in number, size, and local situation in the uterus, forbid the supposition that more would have been discharged from the ovary. Of such instances I have recorded many in my notes. For example, in a Rabbit, $108\frac{1}{2}$ hours *post coitum* (Table, par. 313.), ten ova were found distributed throughout the two uteri, having a diameter of $\frac{1}{4}'''$ to $\frac{1}{2}'''$, in the nineteenth and other stages. That a discharge of more ova had been destined, is not at all probable; yet in that instance,—besides the incipient corpora lutea, corresponding in number to the discharged ova,—each ovary presented several large and unbroken Graafian vesicles filled with blood (par. 125. 126.).

Ovisacs found in the Infundibulum.

162. On one occasion, with a high degree of vascularity in all the parts, I found in an ovary of the Hog three ruptured Graafian vesicles, with four apparently on the point of bursting†. Bloody strings of a fleshy substance were hanging at the orifices of two out of the three ruptured Graafian vesicles; and in the infundibulum of this side there were several of the same kind of bloody masses, of a string-like form, sug-

† None of them were distended beyond a moderate size, and they seemed to be in a healthy state.

gesting the idea of their having been rolled†. In the other ovary two Graafian vesicles were ruptured, having strings of the same kind of bloody substance pendent at their orifices. In the infundibulum of this side were portions of blood-vessels.

163. Some of the string-like masses found in the infundibulum, as well as those pendent at the orifices of the ruptured Graafian vesicles, on being examined with the microscope, presented the following parts, viz.

1. A multitude of elliptic vesicles, varying in size from about $\frac{1}{40}'''$ and less to $\frac{1}{4}'''$, of a greyish colour, and more translucent than the mass in which they lay imbedded.

2. A fleshy mass saturated with blood, in which these vesicles were found, together with portions of large and empty vessels.

3. Shreds of ovisacs, not presenting the same vascular appearance.

164. One of the vesicles just mentioned is represented in Plate V. fig. 102. It was obviously an ovisac in the course of being absorbed. At *g* are its peculiar granules, or rather vesicles, in an altered state. In the interior of each of them is another vesicle, containing a colourless and brightly pellucid fluid, and surrounded by granules. This inner vesicle is the former nucleus in an altered state (par. 297.). At *f* is the membrane, which unaltered is highly transparent, and very thick. It has become distended, wrinkled, and very thin. The yelk (*d*) seems to have passed into a fluid state; *c.* is the germinal vesicle, thickened, and probably double; and *b.* the germinal spot, having a pellucid centre. Here incipient absorption is seen to have produced the same effect upon several parts as impregnation and maceration.

165. The presence of such objects in the infundibulum appears to be not unfrequent in the Hog. I have observed them also in the Cat. To explain the occurrence of ovisacs in the infundibulum, I suppose the rupture of a large Graafian vesicle sometimes to involve the discharge of many minute ovisacs, which escape from the ovary in consequence, and are probably absorbed. I now return to the ovum of the Rabbit.

The Ovum after it has left the Ovary.

166. The diameter of the Rabbit's ovum, when it leaves the ovary, does not, according to my observations, generally exceed $\frac{1}{12}$ of a Paris line, and in some instances it is still smaller. This extreme minuteness renders its discovery very difficult. It is, therefore, important to determine the time when the expulsion usually takes place (par. 128.), for we thus obtain some notion of the distance in the Fallopian tube to which the ova have advanced. And though in different individuals this distance in a given time may not be constantly the same, still even a general idea of it is of no small advantage. We thus diminish that extent of surface, to examine which, in quest of an object so minute, long appeared to me an almost hopeless undertaking. I trust that future observers, through the Tables of observations to be subsequently

† In connexion with the *rolled* appearance of these masses, I would refer to the muscular state at certain periods of the middle coat of the infundibulum.

given (par. 319.), will be spared in some degree the fruitless labour which, in the absence of such information, it was my misfortune to bestow. An experienced eye may also infer from the condition of the discharged Graafian vesicles or incipient corpora lutea, whereabouts the ova lie. I have already stated that all the ova are discharged from the ovary at about the same time. They are, therefore, in most instances found very near together while in the Fallopian tube; so that if a single ovum be obtained, it may be presumed that the rest are not far off. The Table (par. 319.) shows that I have often found ova at the commencement of the uterus, that is within an inch or half an inch of the Fallopian tube. They seem stationary in that locality for some time.

The size of the minute Ovum no criterion of the degree of its development.

167. The figures in Plates VI. and VII. illustrating "*stages,*" I have thought it proper to draw on fixed scales, scrupulously copying nature in regard to size. If however, these figures be referred to, the not uninteresting fact will be made evident, that there is no fixed relation between the size of the entire ovum, and the degree of development of its most essential parts. An extraordinary instance of this is afforded in Plate VII. fig. 124. where in an ovum of less than $\frac{1}{3}'''$ the embryo had attained a stage far beyond what is usual in ova many times as large (par. 218.). On the other hand, Plate VI. fig. 110. presents an instance in which development (as compared for example with that of the ovum fig. 113.) appeared to have been retarded.

168. Nor do any two parts of the ovum necessarily keep pace with one another; a fact well shown in Plate VII. fig. 124., where the incipient umbilical vesicle ($bb^{2\prime}$) and the structure *am.* are very far behind the embryo in the degree of their development.

169. In the following description therefore of successive stages, it will not in general be desirable to state particularly the dimensions of the ovum, nor minutely to detail the condition of any of its parts but those that serve to mark the stage.

Third Stage of Development.

170. When discharged from the ovary in the state exhibited by Plate V. figs. 96. and 97., the ovum was found in the following condition at the distance of one inch from the infundibulum in the Fallopian tube (Plate VI. fig. 103. α.). The germinal vesicle (c), was visible in the ellipsoidal mass that occupied the centre of the fluid yelk. The latter (d) was obscurely granulous. The proper membrane of the yelk (e) was seen with remarkable distinctness, being indeed, from its appearance as a thick black line, the most conspicuous object in the ovum. The distention of the membrane f had proceeded farther, and in the same proportion a pellucid fluid had been imbibed. The tunica granulosa (g^1) was present, but the retinacula were not distinctly seen†. Ovum $\frac{1}{12}'''$.

171. At β (fig. 103.) the same ovum is shown ruptured, to demonstrate the strength

† Traces of both the tunica granulosa and retinacula are, however, generally discernible, and often distinctly seen, at later periods.

of (*e*) the proper membrane of the yelk, which remained whole and still contained the yelk, though forced through the lacerated membrane *f*. The great thickness of the latter is seen in this figure; as well as the effect of pressure on (g^1) the half fluid tunica granulosa.

Fourth Stage of Development.

172. In Plate VI. fig. 104. α. is represented an ovum of forty-one hours, and measuring $\frac{1}{12}'''$, found about an inch from the infundibulum in the Fallopian tube. The tunica granulosa was not distinct. Around the thick, transparent membrane *f* was a dark circle (*cho*) which at first seemed the outer surface of that membrane, now exhibiting a high refracting power. The yelk (*d*) was obscurely granulous, and the germinal vesicle no longer seen†. At fig. 104. β. is another ovum of the same Rabbit found further advanced into the tube, and here represented after being crushed. This ovum presented the same dark circle (*cho.*) seen in fig. 104. α. On crushing the ovum, however, I found the dark circle to be *a thin membrane closely investing the thick transparent membrane f.* Pressure produced the following changes in that ovum; viz. The yelk-ball, *e*, (fig. 104. α.) became distended so as nearly to fill the membrane *f* (fig. 104. β.); the membranes *e* and *f*, then bursting, discharged their contents, which are seen lying between the membranes *f* and *cho.* No trace of fibres was observed in the membrane *cho.* On being crushed, it not only enlarged, but became elliptical, and bore very considerable pressure before being ruptured. This membrane (*cho.*) appears to be the chorion, which we shall subsequently find to become villous in the uterus (par. 222. 223.). It exhibits no small degree of elasticity.

Fifth Stage of Development.

173. The ovum seen in Plate VI. fig. 105., is one of $35\frac{3}{4}$ hours, and measured $\frac{1}{10}'''$. It was found near the middle of the tube. The thick transparent membrane *f* had more refracting power than in previous stages, and *asperities were observed on its outer surface*; that which previously seemed to constitute its external part having separated in the form of the membrane *cho.* described in the preceding stage‡. Instead of being invested, as in fig. 104. α., by a comparatively thin membrane, the membrane *f* was surrounded by a substance having a gelatinous appearance. The outer surface of this gelatinous looking substance, however, appeared to be constituted by the same

† I have met with an ovum of twenty-three hours (in the Fallopian tube) differing from the one now under consideration, in there being within the yelk-ball (*e*) several large vesicles occupying the situation of the ellipsoidal mass in fig. 103. α., and surrounding a vesicle (germinal vesicle?) apparently having an opacity (germinal spot?) within it. These vesicles were contained in an obscurely granulous and fluid yelk.

‡ Plate IX. fig. 153. represents the mode of origin of the chorion. The ovum seen in this figure was one of seventeen hours, and found with five others near the middle of the Fallopian tube. It measured about $\frac{1}{10}'''$. The chorion (*cho.*) was rising from the thick transparent membrane ("zona pellucida") *f*, and surrounded by what remained of the granules (vesicles) of the tunica granulosa. The chorion was thus in a stage between the stages represented in Plate VI. figs. 104 and 105, while the interior of the yelk-ball (*e*) was less advanced than that in fig. 104. α., the germinal vesicle being still seen (par. 168.).

membrane (*cho.*) which in the last stage closely invested the membrane *f*. If an ovum of the present stage (fig. 105.) be crushed, the membrane *cho.* presents a sensible degree of thickness, and the fluid (f^1) lying between that membrane and the thick transparent membrane *f* is found to have no small consistence. The yelk of the ovum seen in fig. 105. did not present an appreciable difference from that in fig. 104.

Sixth Stage of Development.

174. An ovum of $\frac{1}{9}'''$ found with that just described (Plate VI. fig. 105.) is exhibited in fig. 106. The membranes *cho.* and *f* were in very nearly the same condition as those in the ovum fig. 105. The membrane *e*, however, of fig. 105. had disappeared (by liquefaction) in the ovum fig. 106, and there no longer existed a granulous yelk, as at *d* in fig. 105†. In the ovum fig. 106, the thick transparent membrane *f* ("zona pellucida") was filled with a transparent and colourless fluid (*d*) which it may be proper to designate the yelk. The centre of this fluid was occupied by four large vesicles. These vesicles were spherical, but somewhat flattened. They had a very high refracting power, and being exceedingly transparent, the contour of the remoter ones was distinctly visible through those nearer to the eye. Their contents appeared to be a fluid and granules. Some of these vesicles presented in their interior a minute pellucid space, which may possibly have been a nucleus‡.

Seventh Stage of Development.

175. In an ovum somewhat larger, found in the Fallopian tube, a new set of vesicles (Plate VI. fig. 107.) had arisen, more numerous and smaller than the last, their appearance in other respects being the same. They also occupied a similar situation. The membranes of this ovum, not differing except in size from those of the ovum last described, have not been represented in the present figure.

Eighth Stage of Development.

176. In another ovum from the Fallopian tube, the vesicles in the centre of the ovum (Plate VI. fig. 108.) were found still more numerous and still smaller; in other respects not differing from those in figs. 106 and 107. The membranes of the ovum were in a state very closely resembling that of the corresponding parts in fig. 106.

177. The ovum probably passes through stages, which, in both the size and number of its central vesicles, are intermediate in reference to that I have endeavoured to re-

† The term "yelk"—as applied to the contents of the ovarian vesicle of Baer—has not been discontinued in this memoir; but from the facts recorded in it—and more particularly from the changes delineated in Plate VI. figs. 105½. 106. 107 and 108.—I am disposed to question the analogy which this term implies (par. 122. and *Note.* 318.).

‡ Later observations strengthen this supposition, and enable me to extend it to vesicles in the succeeding stages. The nucleus was very distinct in each of the two vesicles occupying the centre of the ovum in fig. 105½, a stage obviously between my "Fifth" and "Sixth," but not met with in time to be described in its proper place. The pellucid nucleus, however, in all of these vesicles, seems to be present during a certain period only of their existence (par. 315 to 317.).

present in fig. 108, and the condition to be next described. The figures given, however, will suffice to show the nature of the process, which may, perhaps, be analogous to that observed by POUCHET† in the ovum of a species of Limnæus. Possibly also, the divisions and subdivisions first noticed by PREVOST and DUMAS in the ovum of the Frog, and now known to occur in the ova of other Batrachian Reptiles, as well as in those of certain Fishes, may be referable to a process of the same kind‡ (par. 307. 318.).

Ninth Stage of Development.

178. An ovum of sixty-three hours, and of $\frac{1}{7}'''$, is represented in Plate VI. fig. 109. It was found in the Fallopian tube within about an inch of the uterus. The vesicles seen in the centre of the ovum—still minuter than those in fig. 108, and much more numerous—had ceased to be transparent, and were punctate from dark globules, apparently on their outer surface. The vesicles were nearly of equal size, and measured each about $\frac{1}{100}'''$. The structure formed by those vesicles presented a curious resemblance to a mulberry. In the ovum, fig. 109, this mulberry-like object had a diameter of $\frac{1}{25}'''$. The membrane *f* was irregular in its thickness, and at one part had become very thin (par. 190.). Plate VIII. fig. 128. represents the same ovum crushed. The chorion (*cho.*) became elliptical (pars. 172. 222.), a change in form not participated by the membrane *f*. The contents of the ruptured membrane *f*, proceeding no farther than the dotted line, showed this to be the inner surface of a thick membrane—the chorion—which (inner surface) had been concealed by an equal refracting power in the fluid f^1. The fluid f^1 in this instance had a tinge of yellow.

179. VON BAER found a little body in the uterus of the Dog, near the tube, which seems to have been an ovum in a state resembling that of the above. He describes it as consisting of a minute central sphere which was opake, with a transparent halo or periphery. The central sphere (my mulberry-like structure?) he conjectures may have been the vitellus or future intestinal sac, and the periphery he supposes was the "membrane corticale."

Tenth Stage of Development.

180. Seven ova, one of which is exhibited in Plate VI. fig. 110, were found in the Fallopian tube within about three quarters of an inch of the uterus. The mulberry-like structure measured $\frac{1}{20}'''$, presented a greater number of vesicles—which were still somewhat smaller than the last—and the interior of its vesicles was more distinct. Their increased transparency seemed partly referable to the absence of dark globules seen in the preceding stage. Having a high refracting power, their outline was extremely well defined and sharp; more so than I have been able to represent it with a pencil. Within each vesicle was seen an object§ resembling the "germinal vesicle-

† Froriep's Notizen, No. 138, Julii 1838.

‡ SCHWANN has suggested that the divisions in question in the ovum of the Frog, may, perhaps, be reducible to a "cell"-formation (*l. c.* pp. 61, 62.).

§ In one instance two of such objects were observed in the same vesicle (par. 317. *Note.*).

like nucleus" observed by VALENTIN† in "globules" from various parts of the nervous system. This object was round, colourless, and pellucid, and contained a central dark point, resembling the "corpuscle" of the above author. The chorion (*cho.*) was distinguishable from the fluid f^1. Plate VIII. fig. 130, exhibits another of the seven ova crushed. The membrane f is here seen distended and ruptured under the compressor. The mulberry-like object—when crushed—not only filled the cavity of that membrane, but a part of it escaped, and its vesicles became pressed together into figures of several sides. The nuclei remained unaltered: their dark central points (nucleoli), however, in this instance had the appearance of globules. In the space between each vesicle and its nucleus, and chiefly *around the latter*, were now seen granules. Many of those granules, escaped from ruptured vesicles, are represented in the figure, lying in contact with the chorion (*cho.*).

The importance of examining Ova from the Fallopian Tube.

181. CRUIKSHANK‡ found ova of the Rabbit in the tube, and we are indebted to him for very important information regarding their minuteness; but the microscope in his day was not in a state to admit of his seeing their internal structure. His figures therefore are mere specks.

182. There exists another representation of an ovum of the Rabbit (and I believe only one) taken from the Fallopian tube. It is contained in a paper by T. WHARTON JONES§. That ovum was one of "the third day," found with five others in the tube "near where it enters the horn of the uterus," and in size ("$\frac{1}{70}$th of an inch") appears to have been between those which I have represented in Plate VI. figs. 109 and 110. My observations corroborate those of the author just mentioned in reference to the *appearance* of the envelope in ova of this period, but they do not agree with his views as to its real nature. T. WHARTON JONES‖ describes this envelope as "a thick gelatinous matter." In all the ova I examined, the outer portion of the envelope was already in the condition of a formed membrane, which condition it had from the first retained (Plate VIII. fig. 128., Plate VI. fig. 110. *cho.*). (The previous existence and mode of origin of that membrane I have already shown in Plate VI. fig. 104. α. and β. and in Plate IX. fig. 153.). In reference to the interior of ova of this period, my observations do not enable me to corroborate those of JONES; who remarks¶ "the granulary matter of the yelk was coherent." (Contrast with Plate VI. fig. $105\frac{1}{2}$ to 110.)

183. PREVOST and DUMAS†† found no ova of either Dogs or Rabbits in the Fallopian tube, and the smallest ova they saw in the uterus measured $\frac{1}{2}'''$. COSTE‡‡ has not figured an ovum from the tube in any animal. This author remarks§§, "after conception, we have stated, the vesicle which we know to be the analogue of the vesicle of

† Ueber den Verlauf und die letzten Enden der Nerven, figs. 51, 52, 70. 1836.

‡ *L. c.*

§ Philosophical Transactions, 1837, Part II. plate xvi. fig. 1.

‖ *L. c.* p. 339.

¶ *L. c.* p. 339.

†† *L. c.*

‡‡ Embryogénie Comparée.

§§ pp. 109, 110.

Purkinje, dissolves, and the ovum *then* presents itself under the aspect of a *crystalline vesicle perfectly homogeneous*. The space which was occupied by the yelk, the condensation of which has served to form the blastoderma, is filled with a transparent fluid." With this statement I would contrast nine stages of the ovum of the Rabbit from the Fallopian tube (Plate VI. figs. 103—110). Von Baer† has figured one ovum from the Dog, found in the Fallopian tube. It would not, perhaps, be fair to contrast this with ova from the Rabbit; but the Professor certainly came prematurely to the conclusion that "in their passage through the tube the ova of Mammalia undergo scarcely any metamorphosis at all." I refer to Plate VI. figs. 103—110. in proof that there is at least one of the Mammalia to which this statement is inapplicable. Does the Dog differ so widely from the Rabbit, that in the tube its ova undergo scarcely any change?

Eleventh Stage of Development.

184. A layer of vesicles (Plate VI. fig. 111.), in all respects of the same kind as those constituting the mulberry-like appearance before mentioned, had now been added. This layer—resembling an epithelium—lined the membrane *f*, which it will be remembered had been the thick transparent membrane, or "zona pellucida" of the ovarian ovum. The mulberry was still in the *centre* of the yelk.

Twelfth Stage of Development.

185. The mulberry-like structure (Plate VI. fig. 112.) was on its way from the centre to the surface of the yelk. (The chorion (*cho.*) in this instance was distinguishable from the fluid *f'*.)

Thirteenth Stage of Development.—The true Germ.—The so-called "Serous Lamina of the Germinal Membrane" a Structure of subordinate importance.

186. In this stage the mulberry-like structure (Plate VI. fig. 113.) has reached the surface of the yelk; its own vesicles on one side, as well as some of those of the peripheral layer, have disappeared, and a vesicle contained in the mulberry-like structure comes into view. This vesicle lies in close contact with the membrane *f*. It is flaccid, and in its present situation appears flattened and elliptical. It contains a fluid and dark granules, and highly refracts light, which seems partly owing to the presence of those granules in considerable quantity on its inner surface. In two instances this vesicle measured in its long diameter about $\frac{1}{30}'''$; in another instance rather less. In the centre of the fluid of this vesicle is a spherical body (*bb*), yellowish brown in colour, and composed of a substance having a finely granulous appearance, which is distinctly circumscribed. It has a cavity in its centre containing a colourless and brightly pellucid fluid. This hollow spherical body seems to be the true germ. It measured in the present instance (fig. 113.) $\frac{1}{75}'''$; its central cavity

† Lettre, &c., fig. 3. III. and III*.

less than $\frac{1}{200}'''$. I have seen the stage now before us in a considerable number of ova measuring $\frac{1}{6}'''$ and $\frac{1}{7}'''$†.

187. Authors on the ovum of the Bird describe their "primitive trace" of the embryo as originating in that which has been denominated the "central, thickened part of the germinal membrane." In the mammiferous ovum now under consideration (fig. 113.) the vesicles lining the membrane *f* appear to me to represent the so-called "germinal membrane" (or what has been denominated its "serous lamina"), and the remains of the mulberry-like structure seem to correspond to that which has been considered its "central thickened part." If, however, facts to be hereafter stated should render it very probable that the foundation of the new being is that contained within the mulberry-like object, figs. 109 to 113, it will perhaps appear that this foundation is no part of any membrane. The layer of vesicles (*am.*) lining the membrane *f* (fig. 113.), with those previously constituting the external part of the mulberry-like object, we shall find to form a structure of subordinate importance—the amnion (par. 199. 200.)

Fourteenth Stage of Development.—The Area pellucida.

189. The vesicle described as contained in the mulberry-like structure, and as coming into view in the preceding stage, was no longer to be discerned in the ovum represented in Plate VI. fig. 114. In its place there was an elliptical depression (*a. p.*), filled with a colourless pellucid fluid, presenting an indistinctly granulous appearance at its margin, and containing in its centre the germ (*bb*), which had nearly the same appearance as that in fig. 113, but was somewhat larger. The elliptical depression here mentioned appears to correspond to the *area pellucida* of authors on the Bird.

Fifteenth Stage of Development.

190. The vesicles forming the outer part of the mulberry-like structure had coalesced, where in contact, with those of the layer (Plate VI. fig. 115. *am.*) lining the membrane *f*; but they still formed a projection. The membrane *f* was attenuated (par. 178.), and projected in some degree at the part where the germ was observed to lie. (In another ovum found at the same time, slight pressure caused a sort of hernia at this part, one of the vesicles in the layer *am.* protruding through the membrane *f*. This attenuation of the membrane *f* may perhaps have reference to imbibition.) The vesicles *am.* appeared enlarged or flattened, and pressed together into polyhedral forms (Plate VIII. fig. 129.), and dark globules were seen at their periphery. The interior of those vesicles was very distinct; and if the figure now referred to be com-

† Perhaps it would be more correct to consider the vesicle itself (which forms the interior of the mulberry-like structure) with the whole of its contents as the true germ. The particular period at which the formation of the germ (as such)—within the mulberry-like object—commences, my observations do not enable me to state; but in a stage apparently rather more advanced than that represented in Plate VI. fig. 108, I have seen, on the application of gentle pressure, that the mass of spherical objects, occupying the centre of the ovum, contained a fluid in its interior.

pared with Plate VIII. fig. 130 (which represents an ovum of the Tenth Stage), there will be found this difference; that in the space between the membrane of each vesicle and its nucleus there are seen in the present instance (fig. 129.) a number of dark globules, not present as such in the earlier stage (par. 180.).

191. Von Baer appears from his description† to have met with ova of the Dog in either this or a neighbouring stage; though certainly no drawing given by that eminent observer enables me to recognise the resemblance. He mentions having observed a mass of granules, which was conical in the minuter ova, and in those more advanced discoid in its form.

Sixteenth Stage of Development.

192. The layer of vesicles *am.* in the ovum Plate VI. fig. 116, appeared to be passing into the condition of a membrane. Those parts of that layer which formed the *sides* of the area pellucida (*a. p.*) were raised and approaching one another, while at the ends of that pellucid space there was no such tendency, but, on the contrary, the appearance of depression into a sort of channel. The sides, here seen to have been in near approximation, appear subsequently to come into contact and unite (Plate VII. fig. 121 D.). (If this supposition be correct, Plate VII. fig. 122—representing a much later stage—shows this union to have taken place at one point; and in figs. 121 A. and 121 B. the union has been more extended. In fig. 122. there is seen a circular space on each side of the point of union. These circular spaces seem to represent the parts which in the sixteenth stage had the appearance of being depressed into a sort of channel, or in other words, exhibited no tendency to become raised over the area pellucida).

Seventeenth Stage of Development.—Central and Peripheral Portions of the Germ.—Origin of the Lamina subsequently vascular.

193. About this time the germ separates into a central and a peripheral portion. In the figure representing the present stage (Plate VI. fig. 117.) the ovum is seen in profile, and the germ therefore is not visible. (An idea may be formed of the separation here mentioned from Plate VIII. fig. 148, in which bb^1 is the central, and bb^2 the peripheral portion of the germ‡.)

† Lettre, &c., p. 12.

‡ The germ is here represented in its vesicle as seen while still in the centre of the ovum. (The mulberry-like structure was imperfect, and hence the possibility of seeing the objects in its interior.) In this instance the incipient separation of the germ into a central and a peripheral portion appeared to have been premature. These central and peripheral portions of the germ are represented in Plate VII. figs. 121 A. 121 B. and 122. bb^1 and bb^2. Whether they really arise from a separation of the object *bb* (Plate VI. fig. 113 to 116.) into two portions, future observation must decide. Possibly the object *bb* disappears by liquefaction, and a linear trace, corresponding to the "primitive trace" of authors on the Bird, arises in its place. In either case, however, the terms *central* and *peripheral portion of the germ* will be useful in the present memoir, and in either case the embryo does not arise in the substance of a membrane.

194. Before mentioning the most remarkable feature in this ovum, I would refer to the opinion generally received at present regarding the manner of origin of the "mucous lamina" of the so-called "germinal membrane." This, however, has hitherto been the subject of conjecture only, as will be amply shown by the following extract, containing perhaps the latest that has been written on the subject; and it comes from a very high authority, that of RATHKE †.

"PANDER, BAER, and I,—the former in reference to the Chick, I in reference to the Crafish,—have used the expression that it [the mucous lamina] separates by splitting from the serous. We thus gave it as our opinion, that this process consisted in the splitting of the germinal membrane. More recently BAUMGÄRTNER has expressed doubts of such an origin of the mucous lamina, and advanced the opinion that it becomes deposited upon the serous lamina, by the latter exercising an attractive influence upon the yelk, which determines single parts of the same to arrange themselves densely on it (the serous lamina) to form a new structure [the mucous lamina]." The Professor, after stating his objections to this opinion of BAUMGÄRTNER, says there are only two ways conceivable in which the mucous lamina can arise, viz. it is either thrown off by the serous lamina, or originally there exists a single mass which splits into the serous and mucous laminæ. In order to obtain a solution of this question, he again examined the ovum of the Crafish; but as that did not satisfactorily furnish it, he concludes that it would be advisable again to examine the ovum of the Bird.

195. We thus see that there is still great uncertainty as to the manner of origin of the "mucous lamina" of the so-called "germinal membrane." I have no speculations to offer on the subject, and shall do little more than refer to figures in which it has been attempted to represent nature in ova of one of the Mammalia.

196. From the region occupied by the germ, there extended in the ovum representing the present stage (Plate VI. fig. 117.) a hollow process ($bb^{2\prime}$) consisting of *exceedingly pellucid* objects, which hung loosely together, and were somewhat depressed where in contact. This process seemed to pass through the central part of the now flattened mulberry-like structure, before described, and to be connected with the germ. In what manner it was so connected my observations on that ovum do not enable me with certainty to state; but later stages show it (the process in question) to enter into the formation of a structure ($bb^{2\prime}$) *continuous with* that which I have called the peripheral portion of the germ (bb^2 in several figures of Plate VII.). In later stages this hollow process attains a size sufficient to line the cavity, the centre of which it occupied in the ovum, fig. 117; and probably in proportion as this process widens at its origin, the remains of the former mulberry-like structure disappear. Provisionally I may perhaps be permitted to consider the process in question as an incipient state of the umbilical vesicle. Should it prove to be so, its mode of origin must be very different from that which has hitherto seemed the most probable to authors on the ovum of the Bird (par. 194,). The pellucid objects which hang together and constitute

† Zur Morphologie Reisebemerkungen aus Taurien, p. 104, 1837.

the principal part of the process in question, appear, however, to be the foundation of, not the *mucous*, but the *vascular* lamina of the umbilical vesicle; which latter, therefore, according to my observations, is the first of those two laminæ coming into view. The observations by Rathke† on the Crafish, above referred to, seem to me to contain internal evidence corroborating the description I have just given. Thus he mentions a layer of minute albuminous granules as present on the inner or yelk surface of the germ, soon after it has arisen, these granules being in some parts very loosely connected among themselves. Still more in accordance with my observations on the origin of the umbilical vesicle in Mammalia, are those of the same eminent author in a former series of Researches‡, on the first trace of the subsequent posterior half (that is the abdomen) of the Crafish. This structure, according to Rathke, presents itself as a *little sac, finely granulous in its substance, issuing from the bottom of a depression existing at the surface of the yelk.*

Eighteenth Stage of Development.—First Change in Form presented by the Germ.

197. In Plate VII. fig. 118. bb^1. the central portion of the germ presents a pointed process (par. 213.). In previous stages the germ had a finely granulous appearance, and was comparatively pale in colour. In the ovum now before us (fig. 118.) the central portion of the germ was nearly black, apparently from globules of extreme minuteness. It seemed distinctly circumscribed, and contained a pellucid cavity in its larger end. It measured in length $\frac{1}{30}'''$. (The embryo in its most incipient state is subject to considerable variation in both its form and the appearance of the globules of which it is composed. Of this an instance is afforded in fig. 121 D.)§

198. A dark object, represented in the middle of the same figure (fig. 118.), appeared to line part of the inner surface of the ovum. That object was so obscured by blackish globules that I remain in entire ignorance of its structure; and having seen but a single ovum which in reference to the object in question was in that particular condition, I am equally incapable of stating in what manner it arose. The process ($bb^{2\prime}$) described in the preceding stage was discernible, and the dark object in the present figure may possibly have been situated in the interior of that process. We shall find apparently the same object to present itself in later stages (par. 203—206.).

199. The stratum of vesicles *am.* (fig. 118.) had passed into the condition of a membrane, and the space containing the germ had become more defined. The cause of the latter change appears to be the following; which, however, is offered as no more than probable, as my observations do not extend to a period sufficiently advanced to admit of certainty. That portion of the membrane *am.* (see the figure, and more particularly in later stages, figs. 121 A, 121 B, and 122) which surrounds the germ sinks

† Zur Morphologie, &c. p. 106.

‡ Ueber die Bildung und Entwickelung des Flusskrebses, pp. 12, 13.

§ See that portion of the Note to par. 193. which relates to the possibility of the object *bb* (Plate VI. fig. 113 to 116.) disappearing by liquefaction.

in, while the externally adjacent portion of the same membrane (*am.*) is raised,—the part raised being double. The sinking in of the membrane *am.* around the germ, I suppose to indicate the commencement of a rising or separation of the latter from the surface of the yelk; and the elevation of the adjacent and external portion of the same membrane (*am.*) appears to me to denote the incipient formation of the amnion. To those who have investigated the development of the Bird, this will be familiar. For the information of others it may be added, that (if the explanation given by authors on the ovum of Birds be applicable to that of Mammals) the double membrane *am.*—by continued elevation—is made to arch over the embryo, and finally to meet and join. The outer lamina (of the fold of membrane raised) is then thrown off, while the inner lamina constitutes the amnion. I refer to the plates of Baer†, showing the mode of formation of the amnion in the Bird.

200. In adopting, however, the explanation which has been given of the manner of formation of the amnion in the Bird, I must be understood as maintaining—in opposition to the views of others—that the membrane so appropriated in Mammalia is no part of that structure out of which the embryo is formed (par. 187.). The membrane now referred to as forming the amnion, is that marked *am.* in Plate VI. figs. 113—117. It consists of the epithelium-like layer of vesicles (fig. 111.) on the inner surface of the membrane *f*, to which the vesicles presenting the appearance of a mulberry are subsequently added (fig. 113.), and with which they coalesce (fig. 115.) to form the membrane *am.* in later stages (see Plate VII.).

Nineteenth Stage of Development.—Hollow Network in the Ovum.

201. The process (Plate VII. fig. 119. $bb^{2\prime}$.) first mentioned in the seventeenth stage (Plate VI. fig. 117.), as consisting chiefly of pellucid objects hanging loosely together, has now enlarged so as to apply itself to all parts of the inner surface of the membrane which in other figures has been marked *am.* It now constitutes a membranous hollow network‡. In Plate VIII. fig. 132 is exhibited a portion of this network highly magnified. It presents elliptical enlargements, containing a yellowish turbid fluid, and a nucleus which is spherical, colourless, and *remarkably pellucid.* Around each of these nuclei are dark globules. The pellucid objects entering into the formation of the process $bb^{2\prime}$ in Plate VI. fig. 117 appear to have been incipient vesicles just rising from their nuclei. It is probable, that subsequently those vesicles distend, and at the parts where they are in contact with one another, coalesce in such a manner as to make their cavities continuous. In this way the structure by distention may form the hollow network just described§.

† Ueber Entwickelungsgeschichte der Thiere. Beobachtung und Reflexion. Erster Theil, tab. ii.; also Burdach's Physiologie, vol. II. tab. iii.

‡ This ovum measured $\frac{1}{4}'''$ +. I have met with ova of $2'''$ apparently not more advanced in reference to the network (par. 167. 168.).

§ We shall hereafter find this explanation to be in accordance with Dr. Schwann's view of the mode of origin of capillary vessels (par. 295.), though it is another structure which is here produced.

Twentieth Stage of Development.

202. The network has disappeared (Plate VII. fig. 120.), but the nuclei ($bb^{2\prime}$) which were contained in its enlargements remain. The membrane of the network appears to have liquefied, and furrows filled with fluid mark its former situation. Some of this fluid surrounding the nuclei, points out the place previously occupied by the enlargements in the network. The nuclei have still the peripheral accumulations of dark globules, which existed while they were contained in the network.

203. The nuclei are situated on a lamina internal to them. This lamina may, perhaps, be the dark object mentioned in the "eighteenth stage," which has now enlarged so as to contain the yelk. Whether this lamina is the foundation of the mucous lamina, or whether it contributes to the formation of the lamina subsequently vascular, or to that of both, my observations do not enable me to state.

Twenty-first Stage of Development.

204. The furrows visible in the twentieth stage have disappeared; but the pellucid nuclei remain (Plate VII. fig. 121. $bb^{2\prime}$.), and are still surrounded by dark globules†.

Multiplicity of parts in a minute Ovum.

205. The ovum from which fig. 121. was taken measured $\frac{4}{5}'''$. A drawing of that ovum occupies the centre of Plate VII. (fig. 121 A.). I do not suppose, that with the condition of the future umbilical vesicle exhibited in fig. 121—and forming my twenty-first stage—the state of the whole ovum is always such as that in fig. 121 A,—because as already said (par. 168.) the parts do not necessarily keep pace with one another‡. It may, however, be desirable to mention the structures of which that ovum was composed. (In fig. 121 A. it presents the appearance of *incipient* collapse; this having been the effect of the fluid—kreosote water (par. 239.)—in which it lay when drawn.)

206. Proceeding from the exterior inwards, we find the parts of the ovum in question to be as follows; viz. *cho.* is the chorion; f^1, fluid; *d.* yelk which has escaped from its cavity, and not mixed with the fluid f^1; *f*, the thick, transparent membrane of the ovarian ovum ("zona pellucida"); *am.* the amnion; *am.f*, a part at which the membrane *am.* now adheres to the membrane *f*; bb^1, central, and bb^2 peripheral portion of the germ. Continuous with the peripheral portion of the germ is the subsequently vascular lamina of the umbilical vesicle, $bb^{2\prime}$, having a lamina internal to it. Within the part last mentioned is the yelk.

207. Thus the ovum of the Rabbit may pass through at least one-and-twenty stages of development, and—as in the ovum just described—may contain, besides the

† Von Baer has figured objects seen in an ovum of the Dog, which appear to have corresponded to the nuclei and dark globules above-mentioned. (Lettre, &c. p. 12. fig. V*.) His description of them, however, does not at all accord with my observations on ova of the Rabbit.

‡ And I have met with ova many times as large which were not more advanced in their development.

embryo, four membranes, one of which has two laminæ, before it has itself attained the diameter of half a line; one membrane moreover (denoted by the letter e in some of the figures of Plates V. and VI.) having disappeared by liquefaction in the Fallopian tube. Hence the importance of examining ova when minute. The smallest ova found by PREVOST and DUMAS in the Dog, measured half a line,—that is, rather more than the ovum I have now described. But the ova met with by those observers seemed to them to consist of *a single membrane*†. VON BAER‡ mentions ova from the Dog of the same size ($\frac{1}{2}'''$) as composed of *two membranes*, the inner having granules on its internal surface (par. 204. note). It is, however, only fair to add, that the size of minute ova affords no criterion of the degree of their development,—and also that in this respect there may be a difference in different animals; though these considerations are scarcely sufficient to explain the absence of two or three membranes. The membrane *f*—unless its presence has been ascertained from the examination of very minute ova—may easily escape notice as a separate structure in ova more advanced§.

Adhesion between the thick transparent Membrane of the ovarian Ovum and the Membrane which forms the Amnion.

208. It has just been stated that the membrane *am.* adheres at a certain part to the membrane *f* (Plate VII. fig. 121 A. *am.f.*). I have observed, that the points adhering do not constitute a complete circle or ellipsis, but are interrupted at that part which is in the neighbourhood of the caudal extremity of the embryo. Here the adhesion (at least originally) does not take place. This adhesion appears to correspond to one known to occur in Birds; and possibly it takes place in the Mammal for the same purpose as that which it is supposed to answer in the Bird, viz. to promote the

† *L. c.* No. 188, p. 182. PREVOST and DUMAS state indeed that larger ova of the Dog, viz. $\frac{3}{4}'''$ to $1'''$, consisted of a single membrane.

‡ Lettre, &c. pp. 11, 12.

§ T. WHARTON JONES (*l. c.*, p. 341. and fig. 6.) gives the following description of two ova found in the horn of the uterus of the Rabbit seven days after impregnation, and measuring about $\frac{1}{50}$th of an inch (between $\frac{1}{4}$ and $\frac{1}{3}$ of a French line) in diameter. "No vitellary membrane was to be seen. The gelatinous-looking envelope constituted the only covering of the yelk, which now formed a vesicular blastoderma. The cavity of the gelatinous-looking envelope was much larger than the vesicular blastoderma. The inner surface of the gelatinous coat presented what I supposed to be fragments of the vitellary membrane adhering to it. In both ova the vesicular blastoderma was irregular on one side, that on which I supposed the embryo was about to be developed. It was beginning to present the separation into layers, and had the same peculiar friable globular structure as the blastoderma of the Hen's egg." In reference to this description, I am compelled to state that Plate VIII. fig. 138. represents the vitellary membrane (*f*) entire, as seen by me in an ovum of $\frac{9}{10}'''$; that I have not met with any such phenomenon as the separation of a membrane into layers; and that the result of my observations on the subject of a "vesicular blastoderma"—having a peculiar "friable globular structure"—may be found in Plate VI. figs. 105½ to 117., and in Plate VII. figs. 118 and 119. *am. bb.* and *bb²'*; also in par. 187. 192. 199. 200., and par. 196. 198. 201. The real nature of the "gelatinous-looking envelope" has been already explained (par. 172 to 174. 178. 180. 182.).

rising of the membrane *am.* for the formation of the amnion (par. 199.). In Plate VIII. fig. 145. is exhibited an ovum drawn after it had lain six weeks in dilute spirit. The membrane *am.* (with its contents) is here seen to have been pendent from the membrane *f*, through the adhesion now mentioned. Possibly this adhesion may assist to explain why the incipient embryo which it incloses, is (as I have found it) generally either uppermost or undermost when the ovum is viewed in a fluid medium. The relations of the thick transparent membrane ("zona pellucida") of the ovarian ovum in stages subsequent to that which I have called the "fifth" (Plate VI. fig. 105.), and the adhesion just described as taking place between this membrane and the membrane entering into the formation of the amnion, may, perhaps, be considered as showing the correctness of those who had conjectured the thick transparent membrane to be analogous to the vitellary membrane in the ovum of the Bird (par. 174.).

The Embryo a Congeries of Vesicles.

209. The precise condition of the embryo has not been mentioned in the three last stages; the fact being that its appearance undergoes such rapid changes, and is subject to such variation, that to have attempted to associate any particular condition of it with that of the parts representing those stages, would have been quite fruitless, and moreover calculated to mislead. Besides which, there are so many dark globules mixed with the vesicles, of which the embryo is now composed, that it is extremely difficult to ascertain what the condition of the latter really is;—a difficulty augmented by the tendency in many instances to a sinking in at that part where the embryo lies. If however fig. 118. be compared with fig. 121 A., the following differences will be observed. In the former, the central portion of the germ (bb^1) presented globules of extreme minuteness; in the latter it was a congeries of distinct vesicles, of which moreover there were two states. Those most internal were smaller and appeared nearly black; while those of the outer set were more expanded, and paler in their colour. The peripheral portion of the germ in fig. 121 A. (bb^2) was seen with great distinctness; and between the central and peripheral portions of the germ there were extended cords formed of vesicles, having the appearance and apparently performing the office of retinacula.

Stages of Development later than the Twenty-first.

210. If I have succeeded in making plain the foregoing "stages," later ones will not require to be described so much in detail. Nor is it my purpose to extend the present paper to stages in continuous succession, beyond that which I have called the twenty-first.

Progressive Formation of the Vascular Lamina of the Umbilical Vesicle.

211. The subsequently vascular lamina of the umbilical vesicle in the twenty-first stage (Plate VII. fig. 121. $bb^{2\prime}$.) consisted of scattered nuclei, having peripheral accu-

mulations of dark globules. In a stage somewhat more advanced, though in an ovum of about the same size (Plate VIII. fig. 150.), there were seen, not scattered nuclei, but vesicles pressed together into a polyhedral form, each vesicle containing its colourless and pellucid nucleus. Some of the nuclei contained a dark globule; and in the vesicles were globules, situated especially *on the nuclei* (par. 304.). As already stated, it is probably in this lamina that blood-vessels subsequently form †.

Arrangement of the Vesicles composing the Embryo, and Order of their coming into view as Vesicles.

212. A condition of the germ or embryo seen in Plate VII. fig. 121 B, appears to represent the state succeeding that exhibited in fig. 121 A; and both of these figures, it may be added, were taken from ova of the same Rabbit. The germ in fig. 121 A. has been already briefly referred to (par. 209.). If fig. 121 B. be compared with it, the following differences will be observed. In the earlier state (fig. 121 A.) the peripheral portion of the germ (bb^2) was cordate,—in the latter (fig. 121 B.) it was somewhat lyrate in its form. (In this respect, however, I have observed some variation.) In the less advanced ovum (fig. 121 A.) the central portion of the germ (bb^1) appeared to consist of two parts, an internal and an external,—while in that more advanced (fig. 121 B.) it consisted of three distinct parts,—an internal, a middle, and an external. Thus in the later stage a new part had come into view. The new part seemed to be that which occupied the most central situation, parts previously situated there having been pushed farther out. Each of the several parts or layers now referred to was so distinctly circumscribed, as to appear almost membranous at its surface.

213. More particularly compared, the two figures in question exhibit farther differences. In the less developed ovum (fig. 121 A.) the most internal object was a dark trace, enlarged and hollow at one end, pointed at the other. In the ovum more developed (fig. 121 B.) the corresponding part occupied, not the most internal, but the second or middle place. Instead of being hollow merely at one extremity, it was now a hollow tube, with an enlargement at both ends. The part which had subsequently come into view (fig. 121 B.) was at the cephalic end. This part is shown more highly magnified in fig. 121 C. It consisted of two portions, one of which was spherical, and the other seemed a process from the first. The spherical portion contained a cavity filled with a brightly pellucid fluid. The external surface of this object was distinctly circumscribed, and almost membranous. Its substance appeared granulous at some parts, and at others presented globules or incipient vesicles. At a certain part the formation of globules (vesicles) had proceeded so far as to constitute the process above mentioned; and over this process the outer membrane (if such it may be called) was continued. (This object and the changes now described will perhaps serve to convey

† Whether the lamina represented in Plate VII. fig. 121—as having the scattered nuclei lying on it—enters into the formation of the vesicles in Plate VIII. fig. 150, I am unable to determine.

an idea of the manner in which the central portion of the germ (figs. 118, 121 D. bb^1) undergoes its *first* change in form, already pointed out (par. 197.))†.

214. In fig. 122. is seen a more advanced condition of the same parts. The minute body corresponding to that just referred to in fig. 121 C. had assumed in the embryo fig. 122. a different form (resembling that of the most central part in fig. 121 A.), and in a still later stage (fig. 123.) the corresponding part had in its turn become a tube, having very much the form of that which in the embryo fig. 121 B. occupied the second or middle place‡.

215. The parts are dark in proportion as they lie near to the centre of the germ, which seems owing to the less expanded state of the vesicles of those parts, and to myriads of others which are coming into view.

216. In fig. 122. is a band of vesicles forming a sort of arch. The absence of the membrane *am.* at certain parts has been already mentioned (par. 192.), in reference to this figure as well as others. One object of the open spaces thus occasioned, may possibly be to admit of certain parts of the germ or embryo continuing in more immediate communication with the exterior than would have been the case had a membrane intervened (par. 190.); and coincident with the existence of those spaces is the fact, that the vesicles forming the peripheral portion of the germ do not make their appearance there in the same quantity as elsewhere,—while the accumulation of those vesicles at the parts over which the membrane *am.* does extend, presents the band or arch in question.—The peripheral portion of the germ (including the band or arch just mentioned), as already stated, is continuous with the subsequently vascular lamina of the umbilical vesicle. In later stages, as the central portion of the germ advances in its size, the arch in question seems to undergo a change in its situation, and to become relatively very small (par. 219. and Plate VII. fig. 124. bb^2.). Is not the peripheral portion of the germ the foundation of the heart and great vessels? (Compare, for instance, the arch above referred to in Plate VII. fig. 122. with representations by Professor Schultz § of the origin of those parts in the Bird.) If so, my "peripheral portion of the germ" obviously corresponds to the "area vasculosa" of authors on the ovum of the Bird ||.

Foundation of the Central Portion of the Nervous System and of the Vertebræ.

217. In Plate VII. fig. 127. I have attempted to exhibit the visceral surface of the future central portion of the nervous system and the incipient vertebræ, in an embryo

† See the Note to par. 193.

‡ In these figures the enlargement at the lower extremity indicates the situation of the future sinus rhomboidalis. It is not intended in par. 212 to 215. to be implied that no additions of vesicles are made externally. The nature of these, however, my observations do not enable me to state.

§ Das System der Circulation in seiner Entwickelung, Tab. V. and VI. Stuttgart and Tübingen, 1836.

|| Prevost and Dumas appear to have seen an ovum of the Rabbit in a state between that exhibited in my figs. 123 and 127. (*l. c.* fig. 13.). No observation of mine leads me to suppose with Prevost and Dumas that the Spermatozoa enter into the formation of the central portion of the nervous system; though as to the early appearance of this part, my observations to a certain extent agree with theirs (par. 312.).

which measured rather less than $1\frac{1}{2}'''$ in length. The ovum containing it was fixed in the uterus, and had a diameter of more than six lines. The period was $8\frac{1}{2}$ days. This embryo was brought into view by dilute nitric acid. The foundation of the spinal chord and its sinus rhomboidalis are visible between the two rows of incipient vertebræ. Cruikshank† appears to have seen the embryo of the same animal (the Rabbit) in a condition resembling this.

An Embryo of remarkable Minuteness.—Effects of Flexion of the Embryo.

218. I have stated that within certain limits the size of the entire ovum affords no criterion of the degree of advancement of its parts. In only a single instance, however, have I met with so remarkable a proof of this as is afforded in Plate VII. fig. 124, where in an ovum of less than one third of a line, the embryo had attained a stage in its development approaching to that in another instance in which it measured many times the length. In fig. 124. the embryo was only $\frac{1}{7}'''$—or about $\frac{1}{79}$th of an English inch—in length; being thus little more than half that of the object represented in fig. 122, though the latter was beyond all comparison behind it in the degree of its development. So remarkable a deviation in point of size is probably of rare occurrence.

219. The embryo of the ovum, fig. 124, is shown more highly magnified in figs. 125 and 126. As viewed on one side it might have been compared to a sort of spoon; but on the spinal surface (of which, however, I could not obtain a direct view) it seemed in part unclosed. It was opake, had a granulous appearance, and was yellowish-brown in colour. When first seen the cephalic extremity was somewhat bent upon itself, as represented in fig. 125; and at a certain part the margin had become wrinkled. On slight pressure being applied, this extremity was observed to fall back into the nearly straight condition exhibited in fig. 126, when the wrinkles were no longer seen. The connexion of this wrinkled appearance with flexion of the embryo is interesting. The embryo had the form of a marrow-spoon. Flexion of such an object upon its hollow surface produced wrinkles at the margin. With continued flexion the wrinkles would doubtless have passed into folds. It hence appears that some of the earliest divisions of the embryo into more special forms‡, are effected by the flexion on itself above described§. The fluid in which the embryo was contained (fig. 124.) appeared somewhat gelatinous, and was in no small degree transparent, though in many parts obscured by dark globules. It seemed to be invested by a de-

† *L. c.*, Tab. IV.

‡ See figures of the embryo of the Common Fowl in Huschke's paper on the first development of the eye. Meckel's Archiv, 1832. Sechster Band.

§ Several dark globules noticed lying together at one point, perhaps indicated the incipient formation of the eye. Unfortunately the drawings are in little more than outline. The sketch, fig. 126, was not commenced until I had examined the object for a considerable time, so as to be quite sure that I understood it in all its parts; and then on beginning to draw it, I had produced only what is shown in fig. 126, when the ovum became shrunk, somewhat dried, and so much altered, that I did not venture to proceed, and no addition has been made to that drawing since.

licate membrane, which I conjecture was a part of, and continuous with, the layer of vesicles (*am.*) lining the membrane *f*†. This layer in other parts, it will be observed, was very far behind in the degree of its development (par. 168.). Such was the case also with the process forming, as I suppose, the incipient vascular lamina of the umbilical vesicle $bb^{2'}$. The situation of the latter structure was such as to confirm my views as to its place of origin. A comparatively opake object (bb^{2}) crossed the embryo near its middle, and prevented my seeing the latter distinctly at that part, which therefore has been represented by dotted lines. I am disposed to think that this object corresponded to the arch (bb^{2}) represented in fig. 122. and if so, what has been already stated (par. 216.) on the continuity of that arch with the subsequently vascular lamina of the umbilical vesicle, will be applicable here. Farther, the object bb^{2} in fig. 124. occupied a situation not very remote from that of the future great blood-vessels and the heart‡.

220. The continuity already pointed out (pars. 196. 201—206. 216. 219.) between the peripheral portion of the germ (Plate VII. figs. 121 A. 121 B. 122. 124. bb^{2}.) and the subsequently vascular lamina of the umbilical vesicle ($bb^{2'}$ in the same figures, and in figs. 119. 120. 121; also in Plate VIII. figs. 132 and 150.), appears to me to go very far towards explaining why observers have hitherto supposed the embryo to *arise* in the substance of a *membrane*. I would ask particular attention to the following recapitulation of several of the facts recorded in this memoir; viz. The dark spot designated by Coste the "Tache embryonnaire," obviously corresponds to my "peripheral portion of the germ" (which has the central portion (bb^{1}) lying under, and often very much concealed by it). The germ sends forth a hollow process (Plate VI. fig. 117. $bb^{2'}$.). This process, expanding, receives the yelk into its interior, lines the membrane *am.* as a network (Plate VII. fig. 119. $bb^{2'}$. Plate VIII. fig. 132.), and passing through the stages represented in Plate VII. figs. 120 and 121, subsequently assumes the state exhibited in Plate VIII. fig. 150, which appears to be the immediate foundation of the blood-vessels and the blood. The stage shown in Plate VII. fig. 121. is repeated on a smaller scale in fig. 121 A. Here, and in figs. 121 B. and 122, the separate granules (nuclei) surrounded by dark globules ($bb^{2'}$) were seen to be a part of the layer constituted by the peripheral portion of the germ (bb^{2}) ("tache embryonnaire" of Coste). *External* to the structures now described is the membrane *am.* (Plate VI.

† Whether circular spaces (Plate VII. figs. 121 A. 121 B. and 122.)—such as those described as incipient in the "Sixteenth Stage" (par. 192.)—in the membrane *am.* existed in the ovum fig. 124, my observations do not enable me to state.

‡ In these Researches it has not been my practice to make drawings from recollection. Nor have I considered it sufficient to merely sketch the object while it was before me, and subsequently finish it. Precision requires that the drawings should be completed while the object is still in the field of view. On this occasion, however, from the cause above assigned, such a course was impossible; and figs. 124 and 125. were therefore not drawn until after the object had been lost. Fig. 126, as already stated, was taken while the object was still before me.

figs. 113—117. Plate VII. figs. 118. 119. 121 A. 121 B. 122. 124.), i. e. the "serous lamina" of authors, or the subsequently reflected lamina of the umbilical vesicle. *Internal* to those structures, or rather internal to the lamina of the umbilical vesicle, which is subsequently vascular, lies, when formed, the mucous lamina†.—This, I apprehend, will assist to explain why observers have hitherto supposed the embryo to *arise* in the substance of a *membrane*. It is not a previously existing membrane which originates the germ, but it is the previously existing germ which, by means of a hollow process ($bb^{2\prime}$), originates a structure having the appearance of a membrane‡.

The Chorion.

221. When in describing the thick transparent membrane of the ovarian ovum in the "First Series" of these Researches (*l. c.* par. 52.), I stated my opinion, in unison with that of Coste and R. Wagner, "that this membrane is really the chorion of ova met with in the uterus," I had not discovered the disappearance of one membrane and the coming into view of another membrane in the Fallopian tube. Such, however, is the fact, as made known in an earlier part of the present paper (pars. 174. 172.); but it is one which did not fall under my notice until near the conclusion of these researches, notwithstanding all the pains that had been taken to procure a consecutive series of stages. It affords evidence that I was formerly mistaken in considering the thick transparent membrane of the ovarian ovum to be identical with the outer membrane of the ovum of the uterus, and "the membrana vitelli [*e*] to be still visible, and to have considerable thickness in minute ova met with in the uterus." It is not that thick transparent membrane itself (*f*) which is identical with the outer membrane, or chorion of the ovum of the uterus, but the thin lamina (Plate VI. fig. 104. α and β. *cho.*) which was seen to come into view on crushing an ovum in a certain state in the Fallopian tube. (The membrane (*e*) of the minute yelk-ball, as already mentioned (par. 174.), disappears by liquefaction during the passage of the ovum through the Fallopian tube.) Those who are practically acquainted with the various difficulties to be surmounted in this branch of physiology, will, I think, be disposed to make allowance for this error§. We are now prepared to trace the chorion through its early stages.

222. In Plate VI. fig. 103. α and β. is an ovum found one inch from the infundibulum in the Fallopian tube, at the same time that other ova in a very nearly corresponding state were met with not yet discharged from the ovarium. The next stage is exhibited in fig. 104. α, which presents an ovum taken from the same part of the

† The mucous lamina was possibly incipient in the ovum Plate VII. fig. 118; and if so, it was more advanced in that represented in figs. 120 and 121.

‡ The "tache embryonnaire," above referred to, appears to have been seen in the Rabbit by several observers. An ovum figured by Dr. Allen Thomson (Edinburgh New Philosophical Journal, vol. 9.) represents it as viewed with a low magnifying power; as does also one figured by my friend R. Wagner (Beiträge, &c., Tab. i. fig. 9.), through whose kindness I had an opportunity of seeing the object itself.

§ The membrane *f* in the present paper everywhere denotes that which was called the "chorion," and lettered *f* in my "First Series."

tube as the one last mentioned, but in another Rabbit. The membrane *f* was seen to be surrounded by a dark circle, which on the ovum being crushed, as in fig. 104. β, was found to be a thin membrane, *cho.* In fig. 105. are exhibited corresponding parts, with the addition of a fluid (f') between the membranes *cho.* and *f.* This ovum consisted of *three* membranes, *e*, *f*, and *cho.* In fig. 106. the membrane *e* has disappeared, the membranes *f* and *cho.* continuing in nearly the same state as in fig. 105. The suite of observations in later stages is such as to require no explanation, for the two membranes *cho.* and *f* continue very distinctly recognizable. This will be illustrated by reference to the thirteen consecutive stages in figs. 109 to 119. Plates VI. and VII. Those drawings show that no membrane is formed outside the membrane *cho.* during the periods which they represent; and that none such is formed at later periods, up to the time when villi usually make their appearance on the surface of the ovum, I have satisfied myself by careful examination. It may be added, that the same properties characterizing the membrane *cho.* when first seen as a separate structure (par. 172.), have uniformly presented themselves in later stages, viz. great susceptibility of distention, no small degree of elasticity, and a tendency to become elliptical. These are my reasons for believing that the external membrane which becomes villous in the uterus is that which we have seen to be rendered visible as a distinct structure by crushing an ovum (Plate VI. fig. 104. β.) in a certain stage, from the Fallopian tube; a membrane denoted throughout the figures by the letters *cho.*, and designated in the present paper as the chorion †.

The Chorion becoming Villous.—Mode, Period, and Place of Origin of the Chorion.

223. An early stage in the formation of villi,—the "Saugflocken" of Seiler ‡,—is seen in Plate VIII. fig. 141. The tuft here represented measured in diameter $\frac{1}{50}'''$. It appeared to consist of vesicles containing objects having the form of vesicles. Several of such tufts are shown in profile in fig. 142. Both of these figures were taken from an ovum of $162\frac{3}{4}$ hours, and measuring $1\frac{1}{2}'''$. I have seen incipient villi on an ovum of $\frac{1}{2}'''$; and I have met with ova of $2\frac{1}{4}'''$ without any. Von Baer observed villi in the Rabbit on an ovum measuring $2'''$; while R. Wagner on an ovum of the same size, and from the same animal, found none. Thus the period at which villi begin to form, like that of the development of other structures in the ovum (pars. 168. 169.), seems to be subject to considerable variation. The tufts on the above mentioned ovum (figs. 141. and 142.) were situated at unequal distances: some of them nearly

† Does not the structure which in the ova of oviparous animals (the Frog for instance) corresponds to the chorion of Mammalia, arise in the same manner? In many of the Invertebrata this is obviously the case. (Compare with Plate IX. fig. 153. *cho.* in this memoir, several figures in R. Wagner's Prodromus Historiæ Generationis;—for instance, fig. II^e, V^b, V^c, X^2, XI^a, $XIII^c$, XVI^b.) In the latter, however, we find the chorion to arise in the ovary. T. Wharton Jones has pointed out the resemblance in *appearance* between his "gelatinous envelope" in the ovum of the Rabbit and the ovum of the Frog (*l. c.* figs. 1, 2, and 5.).

‡ Die Gebärmutter und das Ei des Menschen, Dresden 1832, containing excellent representations of the villi of the chorion in later stages.

touching each other, many being about $\frac{1}{20}'''$ apart, and others as much as $\frac{1}{3}'''$ asunder. At the part from which fig. 142. was taken they were most numerous. The villous tufts are yellowish-brown in colour. The very first indication of the formation of villi seems to consist in a few dark globules existing scattered over the surface of the chorion.

224. The mode, the period, and the place of origin of the chorion, are subjects on which physiologists are not agreed. Von Baer† appears to suppose his "sphere creuse à paroi mince" of the ovarian ovum to become the "membrane corticale" (chorion) of ova in the uterus, though he does not express himself with certainty on the subject. Coste‡ and R. Wagner§ consider the thick and transparent membrane (*f*) of the ovum in the ovary to be identical with the membrane called the chorion in the uterus. Purkinje‖, Valentin¶, and Allen Thomson††, maintain that analogy is in favour of the supposition that the chorion originates in the oviduct. Krause‡‡ conjectures that it may be formed after the discharge of the ovum from the ovary, out of the "disc" of granules (my tunica granulosa and retinacula) which surrounds the ovum in that organ. T. Wharton Jones§§ formerly believed the "vitellary membrane"(*f*) to form the chorion, but now supposes "that the gelatinous coat ['proligerous disc'] acquired by the ovum in the ovary, and more especially circumscribed and defined after impregnation, constitutes the only covering of the vesicular blastoderma after the giving way of the vitellary membrane; that this gelatinous-looking coat forms the chorion," &c. My own observations on this subject have been recorded in preceding pages (pars. 172. 173. 221. 222.)‖‖.

225. More particularly, the following are the views of T. Wharton Jones as to the mode, period, and place of origin of the chorion. He says¶¶, "In the ova of the Rabbit, &c. before impregnation, the proligerous disc [= my tunica granulosa and

† Lettre, &c. Commentaire, pp. 39, 40, 55. Von Baer has since expressed the opinion that in some Mammals, the Hog and Sheep for instance, this membrane arises after the ovum has left the ovary, by the secreted albumen—through a coagulation of its surface—forming for itself an investing membrane. He considers that in the Dog, however, the outer membrane of the ovarian ovum continues the outer membrane of ova in the uterus. (Ueber Entwickelungsgeschichte der Thiere. Beobachtung und Reflexion. Zweiter Theil, pp. 185 to 188, 1837.).

‡ Embryogénie Comparée, p. 80.

§ Beiträge, &c., p. 36.

‖ Encyclopädisches Wörterbuch, Zehnter Band, p. 128.

¶ Handbuch der Entwickelungsgeschichte des Menschen mit vergleichender Rücksicht der Entwickelung der Säugethiere und Vögel, p. 39.

†† *L. c.*, p. 453.

‡‡ Müller's Archiv, 1837. Heft I. pp. 28, 29.

§§ *L. c.*, pp. 339—342.

‖‖ I have in two instances observed the chorion to make its appearance at the surface of the thick transparent membrane *f* ("zona pellucida") in ova still in the ovary and apparently about to be absorbed. Maceration seems sometimes to produce a similar effect. See figs. xviii. and xxii. in Bernhardt's dissertation, "Symbolæ ad ovi mammalium historiam ante prægnationem," Wratislaviæ, 1834; and Edinburgh Medical and Surgical Journal, No. 128, Plate i. fig. 3, 1836, in which the transparent space surrounding the ovum appears to me to represent the fluid (f' in my figures) imbibed by the chorion, the latter being perhaps hidden by the surrounding granules of the "zona granulosa" (my tunica granulosa).

¶¶ *L. c.*, p. 340.

retinacula, Plate V. fig. 96. g^1. and g^2.] in which the ovum is imbedded is observed to be composed of a gelatinous substance interspersed with grains, but as yet there appears no distinctly circumscribed envelope." T. Wharton Jones then refers to the views of Krause, and remarks†, "From his [Krause's] observations on the ovum *before* impregnation, he has been led to form much the same opinion regarding the origin of the chorion as is recorded in this memoir." This opinion of Krause appears to have been the following‡. "It may be conjectured that the ovulum on the bursting of the folliculus passes with the disc and layer of albumen into the Fallopian tube, and that *out of the granules of the former* [i.e. the "disc"] the chorion is formed." My own observations do not realise the conjectures of T. Wharton Jones. On the contrary, they show that when the chorion first comes into view, it is not as a "gelatinous coat§," but in the form of a thin lamina *closely investing* the thick transparent membrane or "zona pellucida" (Plate VI. fig. 104. α and β. *cho.*); and that this thin lamina—*itself the incipient chorion*—expanding from the "zona pellucida," imbibes a quantity of fluid into its interior, thickens, and with the imbibed fluid presents a gelatinous appearance,—but that the chorion is not formed out of the gelatinous-looking "coat§", since the outer portion of this "coat" is *from the first* constituted by a membranous structure, the chorion,—and the imbibed fluid which formed the principal part of the "coat" (Plate VI. fig. 105 to 113. f'.) soon passes into the interior of the ovum, leaving the chorion again in close contact with the outer surface of the "zona pellucida" (Plate VI. fig. 117. *cho.* and *f.*) The conjecture of Krause, however, does not appear to me to coincide with that of Jones, so closely as the latter seems to have supposed. So far from this, I think it by no means improbable that—as conjectured by Krause—the so-called "disc" (my tunica granulosa and retinacula) may bring from the ovary the materials out of which the chorion is formed, and it is possible that the granules (vesicles) of the "disc" may coalesce to form it. Thus that portion of the tunica granulosa (g^1) which in the ovum Plate IX. fig. 153. was seen surrounding the incipient chorion (*cho.*) on its rising from the membrane *f*, may have been destined to enter into the formation of the chorion, and to contribute towards the thickening of this membrane, as well as to supply fluid for its imbibition (par. 150. 151.)||.

† *L. c.*, p. 340. ‡ Müller's Archiv, 1837, Heft I. pp. 28, 29.

§ See his fig. 1. *l. c.* plate xvi. See also figs. 109. and 110. in Plate VI. of the present memoir.

|| I am inclined to think that the "very delicate albuminous membrane" figured by Krause (*l. c.*, Taf. I. figs. 4 to 6.) as surrounding a "thin layer of fluid albumen," must have been the incipient chorion (from some cause making its appearance in the ovary) though Krause does not seem to have regarded it as such (compare with Plate IX. fig. 153. in the present memoir). On a former occasion (*l. c.*, par. 49. *Note.*) I stated that an examination of the ovum of the Goat enabled me to attest the accuracy of Krause; but to a certain extent only; for I did not "in any instance find the membrana vitelli surrounded by a fluid as described by Krause, but by the perfectly formed and consistent chorion" (as I then called the membrane *f.*). From this, however, it will be obvious that the "exceedingly distinct" membrane, which I found to circumscribe the yelk in ova of this animal, cannot have corresponded, as I then believed, to the thick membrane figured by Professor Krause in the same situation.

225½. The names that have been given to the outer membrane of the unattached ovum in the uterus, are very numerous. That membrane appears to be the "Exochorion" of BURDACH and of VELPEAU,—the "Membrana corticalis," "Schalenhaut," and "future Exochorion" of BAER,—the "Chorion," "Eihaut" and "future Exochorion" of VALENTIN,—the "Membrane vitelline" of COSTE,—and the "Chorion" of PURKINJE, R. WAGNER, ALLEN THOMSON, and T. WHARTON JONES.

Aborted Ova.

226. Ova apparently aborted are shown in Plate VIII. figs. 133 to 135. These were found in the uterus of different individuals. At fig. 133. is one of *two* ova that were aborted, the development of others found in the same uterus having proceeded duly. I have met with three instances in which *all* the ova found in the same individual appeared to be aborted. See figs. 134 and 135. In the latter figure a vesicle, apparently corresponding to that which I have described as containing the germ (par. 186.), was seen to occupy the centre of the ovum, having a few scattered vesicles around it. This was the case in all the ova (five) found in the same uterus. In some instances of aborted ova (figs. 133 and 134.) the chorion had not made its appearance as a separate structure. In other instances (fig. 135. *cho.*) it had come into view. The aborted ova which I have met with, whether exhibiting a chorion or not, were considerably smaller than is usual in regularly developed ova of corresponding periods. In fig. 133, the yelk-ball was in the state in which I have met with it in the Fallopian tube, in early stages, except that it was much smaller and elliptical. In one instance, fig. 134, two objects resembling the ovarian retinacula were present, but the tunica granulosa had disappeared. When ova were found aborted, I generally examined the ovary, but nothing abnormal was in any of those instances observed in the ova still present in that organ. It is remarkable, that of the ova met with in these researches in the uterus, no fewer than one in about eight should have appeared to be aborted.

227. On one occasion I found six or seven vesicles in the Fallopian tube of $\frac{1}{8}'''$ (Plate VIII. fig. 136.), having a thick transparent membrane, and containing a colourless and pellucid fluid. In some instances granules were observed on their inner surface†.

Effects produced on Ova by Manipulation.

230. Ova of the Rabbit belonging to the periods chiefly considered in this paper are globular, but very little pressure renders them elliptical. The tendency to this change in form is most obvious in ova that have reached the uterus, and appears indeed to be in proportion to their size. This tendency appears to me to lie chiefly in the chorion (Plate VIII. fig. 128. *cho.*), which may be found deserving of notice. PREVOST

† On another occasion upwards of thirty vesicles were observed in the Fallopian tube, measuring from $\frac{1}{77}'''$ and less, to $\frac{1}{210}'''$. These contained also a pellucid fluid, and the larger ones had a thick membrane like that in Plate VIII. fig. 136. The membrane of the minuter ones was very thin.

and Dumas, as well as Coste, observed a tendency in the mammiferous ovum to become elliptical. The former also state that ova from the horns of the uterus in Dogs are at first (that is in an unaltered state) elliptical†.

Effects produced on Ova by certain Chemical Reagents.

231. The mammiferous ovum in its most interesting state being, from its minuteness, very difficult to obtain and also very perishable, it has appeared to me important to discover some medium in which, when found, its examination might be more perfectly accomplished. The smallest ova from the Fallopian tube and uterus, it is my practice to view imbedded in some of the mucus taken from those parts. The larger ova require a transparent fluid to support them. Water does not answer well. Its operation on ova of $1'''$ to $1\frac{1}{2}'''$ appears to be as follows (Plate VIII. fig. 137.): first, the inner membranes (amnion and umbilical vesicle) separate for the most part from the membrane *f*, leaving the latter on the inner surface of the chorion. This separation is produced, not by imbibition, (for the chorion does not at first enlarge,) but by the passage outwards of a portion of the fluid yelk, which now lies between the amnion and the membrane *f*. Secondly, folds appear in the chorion, their direction coinciding with the longitudinal diameter of the now elliptic (par. 230.) ovum, which soon collapses in a shell-like form (fig. 137.).

232. I have tried solutions of various chemical reagents. Some of these occasioned collapse of the chorion. Others coloured it highly, which was found a disadvantage, although that colour was transparent. Another set rendered it opake. By some it became constricted. Others caused too entire a separation of the internal membranes from the chorion. Now all of these are unfit for the purpose. We require a reagent that does not materially affect the chorion, and yet one that renders more distinct the internal objects sought for.

233. The effect of spirit of wine was found to vary with its strength. Rectified spirit (sp. gr. 0·835) acted too energetically, rendering the chorion in some degree opake. Dilute spirit facilitated for a while the examination of the interior of the ovum, by increasing its transparency‡, and the chorion remained unchanged. Considerable collapse, however, of the inner membranes followed. The dilute spirit here mentioned had a sp. gr. of 0·950, and it was of this strength when used combined with other substances.

234. Brine of common salt produced immediate and entire collapse of the internal membranes in ova of $2\frac{1}{2}'''$; the chorion continuing for a while unchanged.

235. I might go on to enumerate the effects of various other reagents, such as ether and hydrocyanic acid; the nitric and acetic acids; sulphurous acid and sulphuretted hydrogen (deoxydizing substances); solutions of various metals, among which were

† *L. c.* No. 189, p. 200.

‡ The internal membranes of minute ova which had been collapsed by water, I have observed to recover themselves on the addition of dilute spirit; but this effect appeared to be of short duration.

mercury, silver, lead, and gold; the acetate and potash-sulphate of alumine; solutions of nutgalls, and of pure tannin, as being astringent; solutions of sulphated indigo and of logwood; and lastly, aqueous solutions of chlorine and of iodine. Some of these produced interesting though unimportant results, but none of them fulfilled all the conditions above indicated.

236. The action of corrosive sublimate (*hydrargyri bi-chloridum*), as the usual test of the presence of albumen, deserves particular notice, because that after an ovum had been digested twenty-four hours in a weak solution of that salt, its transparency was unimpaired, although the internal membranes were contracted and corrugated. That ovum measured $\frac{4}{5}'''$. Another measuring $\frac{3}{4}'''$ was subjected to the action of the same salt with a similar result. Both of these ova were taken from the same individual.

237. Among the most remarkable effects, are those produced by lead and silver. The action of lead, unlike that of corrosive sublimate, seems to be upon the chorion itself, rendering it opake and white, and therefore intercepting the view of the interior. This effect was almost instantaneous. It was the acetate of lead that was employed, to which enough dilute spirit had been added to make the mixture not more than slightly sweetish.

238. Nitrate of silver, diluted with spirit as above, immediately produced the appearance of a beautiful network in the interior of the ovum (Plate VIII. fig. 140.). This was the effect of its action on the membrane of the vesicles constituting the outer lamina of the future umbilical vesicle. Very shortly, the interior of those vesicles became remarkably distinct. See Plate VIII. fig. 150, taken from an ovum of $\frac{2}{5}'''$ as seen lying in a solution of this salt. Nitrate of silver when used for the examination of the vesicles in question while still within the ovum, should be sufficiently diluted, or it will render the chorion opake. If weak, its action seems to be more perceptible upon the interior of the ovum than upon the chorion. Three ova after remaining in the above solution of silver twenty-four hours, had become of a purple brown colour; solar light having been admitted into the room.

239. I have lately chanced to see Professor JOHANN MÜLLER's paper† recommending kreosote water as a medium for preserving nervous substance, and have been induced to try its effect upon the ovum. It answers well, as will be obvious on reference to Plate VIII. fig. 138.; this drawing having been taken after the ovum had lain three days in that fluid. I recommend a saturated aqueous solution of kreosote in preference to any other medium, for the examination of the entire ovum. Its operation on ova of about $\frac{9}{10}'''$ is as follows. The inner membranes (see the figure) recede to some extent from the membrane *f*, which continues in contact with the chorion (*cho.*). The chorion generally remains unaltered in both form and size. The change, therefore, consists, not in imbibition from the exterior‡, but in the passage outwards of a portion

† MÜLLER's Archiv, 1834, Heft I.

‡ In a very minute ovum, however, immersed in kreosote water, I observed some imbibition from the exterior and consequent enlargement.

of the fluid yelk (*d*) which now lies between the amnion (*am.*) and the membrane *f*. Besides a separation from the membrane *f*, the receded membranes exhibit some separation from one another. See Plate VII. fig. 121 A. representing an ovum in which, by kreosote water, a change of this kind was produced, just sufficient to make the true nature of the interior of the ovum obvious, including the vesicles of the embryo (bb^1 and bb^2) and the nuclei composing the outer lamina of the umbilical vesicle ($bb^{2'}$), to which it imparted a slight tinge of yellow. Instead of using (as mentioned above, par. 231.) the mucus of the uterus for the examination of the minuter ova found in that organ, I have sometimes employed kreosote water in the following manner. A minute portion of this fluid having been placed upon a plane glass surface, the ovum, first freed by bibulous paper from the adherent mucus, is introduced into it, and thus examined either with or without the compressor. If the compressor be not employed, it is important by means of a very fine hair pencil to add kreosote water frequently, so as to keep the ovum from becoming dry.

240. Tar water has advantages in producing no collapse of any part. See Plate VIII. fig. 139., drawn after an ovum had lain four days in this fluid. It appears, however, to constrict the chorion, and it has the effect of colouring too highly.

241. For preserving ova I have tried several fluids. Dilute spirit and kreosote water seem each to answer pretty well; but there occurs eventually too great collapse of the inner membranes. (See par. 313. and third Note.)

Some of the earliest appearances of the Ovum.

242. In Plate V. figs. 82 to 84, are objects apparently representing stages in the formation of the mammiferous ovum even earlier than any of those met with in the "First Series" of these researches. Of the objects now referred to, which were met with incidentally, those in nearly the same stage were observed to lie together in a group. The three groups of which specimens are given in the above figures were in the immediate neighbourhood of one another, and they were all contained in a fluid substance. The most primitive of these three conditions appears to be that represented in fig. 82., in which are vesicles surrounded merely by dark granules or globules. The largest vesicle in this figure had a diameter of only $\frac{1}{100}'''$. I have seen vesicles having a similar appearance, in the same group, measuring no more than about $\frac{1}{300}'''$; and from their external appearance I am ready to suppose that they were compound, consisting of at least two membranes, the one closely invested by the other. The next stage noticed, is that in fig. 83. Here were found central vesicles having the same appearance of a compound structure as the foregoing, but being in general larger (the largest in the figure measured $\frac{1}{75}'''$), and each presenting an envelope of smaller vesicles. Among the latter were many dark granules or globules. In fig. 84. is seen a stage somewhat more advanced. The central vesicles had essentially the same appearance as the foregoing, but were generally larger (the largest in the figure was about $\frac{1}{50}'''$), and their envelopes of vesicles seemed more perfectly formed, and were

free from the dark granules or globules of the preceding stage. One of the central vesicles in this figure presented an indistinct spot. The object in fig. 81. is from the ovary of the common fowl. Its central part resembled the objects in figs. 83 and 84. from the Rabbit (par. 292. *Note.*).

Facts noticed by preceding Observers, cited to show the Accordance in various respects between the Development of Mammalia and that of other Animals.

243. I have copied from CARUS† the drawing of a structure (Plate VIII. fig. 131.) occurring in the ovum of one of the Mollusca,—*Unio tumida.* With this I would compare fig. 130. The latter represents a structure of the same kind as that which in Mammalia closely invests the embryo, and seems to enter into the formation of the *amnion*; the former exhibits an object which, in the molluscous animal above-mentioned, appeared to CARUS to be the foundation of the *shell.* The Professor saw a similar structure in ova of *Anodonta.* The "rhombick fields" in the figure from CARUS, as that author terms them, (which appear to me to have been vesicles with nuclei) seemed to *become more numerous* as development proceeded. With this observation I would compare what has been stated (par. 174 to 178. 180. 314 to 318.) regarding the greater number and smaller size of the successive sets of vesicles in the mulberry-like structure met with in several stages of the mammiferous ovum, (Plate VI. figs. 105½ to 110., Plate VIII. fig. 130.).

244. In the ovum of some of the Crustacea, there occurs a striking resemblance in appearance to the structure, just referred to in the Mammalia, when it has attained a more advanced stage. Such for instance is the case in the ovum of the Crafish, *Astacus fluviatilis*‡. Spiders present in their ova a resemblance equally remarkable. With Plate VI. fig. 114. *am.* I would compare, for example, the ova of *Epeira diadema*, as figured by HEROLD§. Now in those animals, the structure which I suppose to correspond to that marked *am.* in my figures, appears to enter into the formation of the *outer covering of the abdomen.*

245. In none of the figures of the authors last referred to, have I been able to discover any trace of what seems to me entitled to be denominated a "germinal membrane." But, on the other hand, there is to be recognised in a great number of those figures, an unquestionable similarity at the part where the embryo arises, to the corresponding part in the ovum of Mammalia.

246. RATHKE describes a depression in the ovum of the Crafish‖, and also in that of *Bopyrus squillarum*¶, which in some respects appears closely to resemble that which I suppose to be the corresponding part in Mammalia, as shown in Plate VI. fig. 114. *a.p.*

† Neue Untersuchungen über die Entwickelungsgeschichte unserer Flussmuschel, Tab. II. fig. 1.

‡ RATHKE, Flusskrebs, Tab. I.

§ Untersuchungen über die Bildungsgeschichte der Wirbellosen Thiere im Eie, Theil I.

‖ Flusskrebs, Tab. I. fig. 2.

¶ Zur Morphologie Reisebemerkungen aus Taurien, p. 44.

Of *Bopyrus* he says, "when the formation of the embryo is about to commence, there arises on one part of the yelk a minute, pellucid, and perfectly colourless spot"†. "Where this spot is, there is presented a long and broad, but very shallow depression."—"The above-mentioned colourless spot does not indicate a very great thickening of the germinal membrane, but only a space behind the external membrane of the ovum (Eihaut), which is perhaps filled with a fluid as clear as water, for after the operation of diluted nitric acid that part had not in the least lost its transparency." The same author describes in the Amphipoda‡ a "tray-like depression" as occurring on the surface of the ovum. In certain Decapoda§ (*Crangon* and *Palæmon*) he mentions "a place where the yelk to some extent is somewhat flattened, having at the same time receded, and where a disc of little thickness, consisting of a substance as transparent as the purest glass, lies upon the yelk."

247. In ova of the Actinææ, RATHKE found that *no "germinal disc" or "germinal membrane" arose* which could develope itself into an embryo; and hence concludes that here the formation of the new being must take place in a manner entirely different from that which occurs in Mollusca, Insecta, Crustacea, and Vertebrata‖.

249. The acknowledged existence of an "area pellucida,"—for instance in the ovum of the Bird,—is opposed to the present views of authors, that the embryo arises in the substance of a membrane; but it accords perfectly with the fact (Plate VI. fig. 114.), that the germ or future embryo of Mammalia is contained in such a pellucid area.

250. RATHKE in a recent paper¶, though not doubting that the "primitive trace" is constituted by the "central portion of the germinal membrane" (for he uses these terms synonymously), makes known the fact,—observed by him in Mammals, Birds, and some Reptiles,—that parts previously supposed to be formed by what BAER had denominated the "laminæ ventrales of the serous lamina of the germinal membrane," really originate independently of any membrane. These parts are the ribs and pelvic bones and the muscles of the thorax and abdomen, which, according to RATHKE, arise in a newly added substance "proceeding out of the primitive trace," and pushing the membranous "laminæ ventrales" farther and farther from the latter. Observations previously made by REICHERT†† are referred to by RATHKE as being in accordance with the above. REICHERT had found that the part originating the lower jaw and hyoid bone "grows out of the primitive trace." Now if, from the facts made known in the present memoir, it should appear that the "primitive trace" is not constituted by the central portion of a membrane, it will be easy to understand that the parts above referred to by REICHERT and RATHKE should have an origin equally independent of a membrane.

251. An appearance in the development of the Frog and Salamander has been thus

† Zur Morphologie, &c., Tab. II. fig. 1. ‡ *Ib.*, p. 74. § *Ib.*, p. 83.

‖ Zur Morphologie, &c. p. 15. ¶ MÜLLER'S Archiv, 1838, Heft IV.

†† Ueber die Visceralbogen der Wirbelthiere, Berlin, 1837.

described by Rathke†. "Soon after the development of the ovum of these amphibia has commenced, the germinal membrane *becomes in one part more and more thickened*, and the thickening presents itself under the form of a moderately broad lamina, extending about the distance of from one pole of the yelk to the other‡. *Around this lamina, which is the primitive portion of the embryo*, the germinal membrane becomes somewhat drawn in; and at this time the two ends of the lamina (which are the cephalic and caudal extremities of the embryo) *grow forth like two liberated processes* out of the germinal membrane, becoming at the same time curved so as to approach one another around the yelk, as it were striving more and more to embrace the latter." The "thickening" here mentioned, of the supposed "germinal membrane," and the consequent appearance of a "*lamina*," the two ends of which "*grow forth like liberated processes*," admit, I respectfully suggest, of a different explanation. That "*lamina*," the "*primitive portion of the embryo*," appears to me to correspond in its situation and manner of growth to the *germ*, which it has been my endeavour to show is the foundation of the mammiferous embryo. The membrane, however, (*am.* in Plates VI. and VII.) in Mammalia which becomes "drawn in" merely *invests* the embryo, and is *not continuous with it* (see par. 220.). Is it not really so with the "lamina" in question, in the amphibia above-mentioned, as well indeed as with the corresponding part in other animals?

252. Judging from my observations made on the mammiferous ovum, I am convinced that Baumgärtner§ has very accurately described a comparatively early appearance of the embryo of the Frog, as regards both form and substance.

253. It has been conceived‖ that in vertebrated animals the brain and spinal cord form on the *outer* side of the so-called "serous lamina of the germinal membrane," the foundation of the extremities being situated on the *tube* which that "membrane" has been supposed to form; but that in Invertebrata, the chain of ganglia arises on the *inner* or yelk side of that "lamina," and that the extremities on the other hand make their appearance on its *outer* side. I would submit, however, that the difficulty here has been in no small degree attributable to the prevailing opinion that the embryo arises in the substance and by the foldings of a membrane.

Recapitulation.

254. The difference perceptible between the mature and immature ovum consists in the condition of the yelk; the yelk of the mature ovum containing no oil-like globules (par. 120. 122. and *Note*. 124. *Note*.).

255. Both maceration and incipient absorption produce changes in the unimpreg-

† Flusskrebs, p. 86.

‡ The Professor here refers to the authority of Prevost and Dumas, of Rusconi, and of Baer.

§ Müller's Archiv, 1835, Heft VI. The previous work of Baumgärtner, on the Frog, I regret to say I have not seen.

‖ Rathke, Flusskrebs, pp. 77 to 91.

nated ovum, which in some respects resemble those referable to impregnation (par. 123. 124. 160.).

256. During the Rut, the number of Graafian vesicles appearing to become prepared for discharging their ova, exceeds the number of those which actually discharge them (par. 125.).

257. Ova of the Rabbit which are destined to be developed, are in most instances discharged from the ovary in the course of nine or ten hours *post coitum*; and they are all discharged about the same time (par. 128. 130.).

258. There is no condition of the ovum, uniform in all respects, which can be pointed out as the particular state in which it is discharged from the ovary; but its condition in several respects is very different from that of the mature ovum *ante coitum* (par. 140.).

259. Among the changes occurring in the ovum before it leaves the ovary, are the following, viz. the germinal spot, previously on the inner surface, passes to the centre of the germinal vesicle; the germinal vesicle, previously at the surface, passes to the centre of the yelk; and the membrane investing the yelk, previously extremely thin, suddenly thickens. Such changes render it highly probable that the ovary is the usual seat of impregnation. This opinion is not incompatible with the doctrine that contact between the seminal fluid and the ovum is essential to impregnation, since in the course of these researches it has been found that spermatozoa penetrate as far as to the surface of the ovary (par. 143 to 147.) †.

260. The retinacula and tunica granulosa are the parts acted upon by the *vis a tergo* which expels the ovum from the ovary. These parts are discharged with the ovum, render its escape gradual, perhaps facilitate its passage into the Fallopian tube, appear to be the bearers of fluid for the immediate imbibition of the ovum, and probably enter into the formation of the chorion (par. 148 to 151. 225.).

261. After the discharge of the ovum from the ovary, the ovisac is obtainable free from the vascular covering, which together with the ovisac had constituted the Graafian vesicle. It is the vascular covering of the ovisac which forms the *corpus luteum*. Many ova, both mature and immature, disappear at this time by absorption (par. 154. 156. 158.).

262. In some animals, minute ovisacs are found in the infundibulum; the discharge of which from the ovary appears referable to the rupture of large Graafian vesicles, in the parietes or neighbourhood of which, those ovisacs had been situated (par. 162 to 165.).

263. The diameter of the Rabbit's ovum when it leaves the ovary, does not generally exceed $\frac{1}{12}$ of a Paris line (= about $\frac{1}{135}$ of an English inch), and in some instances it is still smaller (par. 166.).

264. The ovum enters the uterus in a state very different from that in which it leaves the ovary. Hence the opinion of Baer, that "in their passage through the

† See the Notes to par. 145 and 278.

tube the ova of Mammalia undergo scarcely any metamorphosis at all," is erroneous (par. 181 to 183.). Among the changes usually taking place in the ovum during its passage through the Fallopian tube are the following; viz. 1. an outer membrane, the chorion, becomes visible; 2. the membrane originally investing the yelk, which had suddenly thickened, disappears by liquefaction; so that the yelk is now immediately surrounded by the thick, transparent membrane ("zona pellucida") of the ovarian ovum; 3. In the centre of the yelk, there arise several† very large and exceedingly transparent vesicles. These disappear and are succeeded by a smaller and more numerous set. Several sets thus successively come into view, the vesicles of each succeeding set being more numerous and smaller than the last, until a mulberry-like structure has been produced, which occupies the centre of the ovum. Each of the vesicles of which the surface of the mulberry-like structure is composed, contains a colourless and pellucid nucleus; and each nucleus presents a nucleolus (par. 170 to 180.).

265. In the uterus, a layer of vesicles of the same kind as those of the last and smallest set here mentioned, makes its appearance on the whole of the inner surface of the membrane which now invests the yelk. The mulberry-like structure then passes from the centre of the yelk to a certain part of that layer (the vesicles of the latter coalescing with those of the former, where the two sets are in contact, to form a membrane—the future amnion), and the interior of the mulberry-like structure is now seen to be occupied by a large vesicle containing a fluid and dark granules. In the centre of the fluid of this vesicle is a spherical body, composed of a substance having a finely granulous appearance, and containing a cavity filled with a colourless and pellucid fluid. This hollow-spherical body seems to be the true germ‡. The vesicle containing it disappears, and in its place is seen an elliptical depression filled with a pellucid fluid. In the centre of this depression is the germ, still presenting the appearance of a hollow sphere (par. 184 to 186. 190. 189.)§.

266. The germ separates into a central and a peripheral portion§, both of which at first appearing granulous, are subsequently found to consist of vesicles. The central portion of the germ occupies the situation of the future brain, and soon presents a pointed process. This process becomes a hollow tube, exhibiting an enlargement at its caudal extremity, which indicates the situation of the future sinus rhomboidalis. Up to a certain period new layers come into view in the interior of the central portion of the germ, parts previously seen being pushed further out (pars. 193. 209. 197. 214. 212.).

267. From the region occupied by the germ there issues a hollow process, which by enlargement is made to line the inner surface of the ovum,—that is to say, the

† There arise at first two vesicles, then four or more, and so on. (See par. 174 and second Note, also par. 314 to 318.)

‡ See, however, the first part of the Note to par. 186.

§ See, however, the Notes to par. 186. 193. 197.

inner surface of the membrane entering into the formation of the amnion (which corresponds to the "serous lamina" of authors), and the process now lining it represents an incipient state of the subsequently "vascular lamina" of the umbilical vesicle —a lamina continuous with the structure corresponding to the "area vasculosa" of authors on the Bird (pars. 193. 201 to 204. 211. 216. 219. 220.).

268. There does not occur in the mammiferous ovum any such phenomenon as the splitting of a "germinal membrane" into the so-called "serous, vascular, and mucous laminæ" (par. 194 to 196.).

269. Nor is there any structure entitled to be denominated the "germinal membrane;" for it is not a previously existing membrane which originates the germ,—but it is the previously existing germ which, by means of a hollow process (par. 267.), originates a structure having the appearance of a membrane (par. 220.).

270. The structure entering into the formation of the amnion is no part of that which constitutes the embryo (pars. 199. 200.). The first appearance of the amnion is in the form of an epithelium (par. 184.). From the delineations of authors it appears to be a corresponding structure, which in Mollusca is the foundation of the shell, and in Crustacea and Arachnida that of the outer covering of the abdomen (pars. 243. 244.).

271. The most important of the foregoing facts respecting the development of the mammiferous ovum, however opposed they may be to received opinions, are in accordance with, and may even explain, many observations which have been made on the development of other animals, as recorded in the delineations of preceding observers (par. 243 to 253.).

272. The ovum may pass through at least one-and-twenty stages of development,—and eontain, besides the embryo, four membranes, one of which has two laminæ,—before it has itself attained the diameter of half a line (par. 207.), a fifth membrane having disappeared by liquefaction within the ovum (par. 174.).

273. The size of the minute ovum in the Fallopian tube and uterus affords no criterion of the degree of its development; nor do any two parts of the minute ovum in their development necessarily keep pace with one another. The embryo sometimes attains a considerable degree of development in its form when exceedingly minute (pars. 218. 219. 167. 168.).

274. The proportion of ova met with in these researches in the uterus which seemed to be aborted, has amounted to about one in eight (par. 226.).

275. With slight pressure the ovum, originally globular, becomes elliptical. Its tendency to assume the latter form is referable chiefly to a property of the chorion, and seems to be in proportion to the size of this membrane (par. 230.).

276. The chorion is not—as was supposed in the "First Series" of these Researches —the thick transparent membrane ("zona pellucida") itself of the ovarian ovum, but a thin lamina which rises from the surface of that membrane, thickens, imbibes fluid, and is for a while separated from that membrane by the imbibed fluid. The fluid

then passes into the interior of the ovum, leaving the chorion again in close contact with the membrane from which it rose. That the lamina in question is really the chorion, has been shown by tracing it from its origin in the Fallopian tube up to the period when it becomes villous in the uterus (pars. 172. 173. 178. 180. 182. 221 to 225½.).

Postscript.

277. It was not until after the foregoing memoir had been presented to the Royal Society, that a recent work by Professor Rudolph Wagner, on the Physiology of Generation and Development†, came into my hands. That volume contains an account of some researches by Bischoff on the ovum of the Dog in the Fallopian tube and uterus, which (though the plates intended to illustrate them have not yet appeared) it may be proper to notice here.

278. It is easy to understand that the ova of the Dog and Rabbit should, even at a very early period, be distinguishable by peculiarities in their development; but it is difficult to account for differences so remarkable as those which present themselves on comparing the statements of Bischoff with my own. There are only two observations, indeed, in which we seem to be agreed; viz. that the Spermatozoa penetrate as far as to the ovary‡, and that ova are often found lying near together in the Fallopian tube. In other respects there appears to be little or no agreement between the observations we have respectively recorded. Several of these, however, relate to points of cardinal importance. Thus Bischoff maintains that the ovum receives no new external covering, but that the "zona pellucida" of the ovarian ovum is identical with the chorion of the uterus. This, as already stated, was formerly my own opinion; and so nearly are the disappearance of one membrane and the coming into view of another membrane simultaneous, that it was not until near the close of these Researches that I was undeceived (par. 221.). Bischoff states that during the passage of the ovum of the Dog through the tube, the yelk undergoes changes in its form, becoming angular; and he mentions certain granulous rings of what he supposes the second or inner membrane; also that in some ova *from the uterus* he found the yelk uniform (in its consistence) and opake. I refer to my own figures for an explanation of those apparent rings; and am compelled to add, that in the ovum of the Rabbit I have not met with any solid substance uniform in its consistence, for a considerable period *before the exit of the ovum from the Fallopian tube.* Can it have been that the

† Lehrbuch der Physiologie, Erste Abtheilung, Physiologie der Zeugung und Entwickelung. Leipzig, 1839. This work contains within the small compass of 140 pages, a luminous account of the present doctrines on generation and development, together with a number of new facts observed by the author.

‡ A Note has been added in a preceding page (par. 145.), acknowledging that Bischoff preceded me in this discovery. Towards the end of June 1838 he observed Spermatozoa on an ovary of the *Dog*. On the 5th of the following September I found those animalcules on an ovary of the *Rabbit*, and the next day (Sept. 6) observed a single Spermatozoon on the ovary of another Rabbit. Early in the following December R. Wagner found Spermatozoa in the Dog between the fimbriæ, close to the ovary.

successive groups of vesicles (Plate VI. figs. $105\frac{1}{2}$ to 110.) which occupy the centre of the ovum (and are finally (fig. 113.) found to contain the germ in their interior) were described by Bischoff as an "angular" yelk? That observer recognises a "germinal membrane" in the ovum of the Dog. According to my observations the embryo of the Rabbit does not arise in the substance of a membrane†.

279. In addition to the foregoing statements of Bischoff, it may not be improper to refer to existing views rather more fully than I have hitherto done; from which it will perhaps appear that the difference between many of those views and the opinions I have been compelled to form, is mainly attributable to the absence of a suite of early stages.

280. R. Wagner, in the latest work that has appeared on the subject‡, remarks as follows. "In mature ova, impregnated or susceptible of impregnation, the germinal vesicle disappears. How this takes place, whether in consequence of a sudden bursting, or through rapid dissolution and liquefaction, flattening down, diminution of its contents, &c., does not admit of being with certainty determined; so much is certain, that the germinal vesicle has always disappeared as soon as the ovum has left the ovary. On the immediate changes consequent upon the disappearance of the germinal vesicle we have no more than mere hypotheses, for observation has hitherto given no explanation of them." The same eminent author subsequently remarks, "Of all occurrences in the history of development, the reception of the ovum into the tubes, and its progress until it reaches the uterus, is the most veiled in obscurity. In Man no one has yet succeeded in observing ovula in the tubes: and it belongs to the most difficult and delicate of anatomical examinations to discover objects so minute even in Mammals, in which the time of impregnation may be so exactly known. In Rabbits the ovula pass into the uterus from three to five days after impregnation, in Dogs from ten to twelve days. In these animals—whose earliest period of development is the best known—several ova are separated and pass in succession—rarely together—into the uterus; and it would seem that the Graafian vesicles also often do not all burst at the same time, but that single ones may burst several days before the rest. The ovula undergo but little change during their passage through the tubes; they take with them from the Graafian vesicle a part of the granulous stratum, which as an irregular, lacerated, disc-like structure, remains adherent to them, but is soon stripped off§." "As soon as the ovula have passed out of the oviduct into the uterus, they undergo the first remarkable changes, and grow rapidly. The following applies chiefly to the Dog and Rabbit, whose ova have been the most frequently examined.

† Since the above was written I have seen the plates of R. Wagner's work, referred to in par. 277 (Icones Physiologicæ. Fasciculus primus, 1839). They are truly admirable. In reference, however, to the Figures from Professor Bischoff (tab. VI. fig. III. to VIII.), I am compelled to state my belief, that while they serve to show this very talented observer to be in advance of others in his acquaintance with the mammiferous ovum, they also confirm an opinion I had previously formed—that he did not obtain a suite of early stages.

‡ Lehrbuch der Physiologie, 1839, pp. 57, 58.

§ p. 94.

The ova, which in the ovary measured only $\frac{1}{10}$ to $\frac{1}{12}$ of a line, have reached the size of $\frac{1}{2}$ to $\frac{3}{4}$ of a line. It is distinctly seen that the chorion distends and becomes thinner; the yelk-ball swells, but becomes more fluid; as the dark granules disappear larger drops of oil come into view; at the same time the superficial granulous layer of the yelk acquires a membrane-like consistence, and the granules present little accumulations, which are insulated, and soon form, at a certain place, an opake circular spot, which in ova measuring a line is perceptible as a minute point with the naked eye. This spot consists of a stronger aggregation of granules, which rises somewhat scutiform—being thicker than the remaining membrane—and soon becomes rather more pellucid in the centre, while the granules group themselves wall- or ring-like at the circumference. The granules of this disc appear to be distinct cells [vesicles], having in the centre a minute opake nucleus. The double membrane of these minute ova is seen very distinctly when the ova have been but a few seconds in water; the outer perfectly transparent membrane—which has no distinct structure—separates very quickly from the inner, which invests the yelk and bears the granulous spot. The outer membrane is the former chorion ['zona pellucida'], the inner is the germinal membrane, blastoderma, which as a membrane has already grown around the entire yelk, and perhaps at an earlier period—as a continuous granulous layer—invested the same, while in the Bird as a disc-like object it occupies only a minute space on the yelk. Probably the space between the two membranes is filled with a thin layer of albumen, which the ovulum has acquired in the oviduct and uterus, and which swells by imbibition in water, producing a greater separation of the two membranes. The granulous spot is the place from which the formation of the embryo proceeds, and hence has by some been called the embryonal spot (tache embryonnaire of Coste). Whether the outer membrane continues to be the most external and becomes the villous chorion, or whether yet a delicate membrane, as exochorion, forms around it, which some maintain, is doubtful; but the former is the more probable. The ova still lie loose in the uterus, and have passed from the round to the oval form †."

Rotatory Motions of a Mulberry-like Object in Vesicles under the Mucous Membrane of the Uterus.

281. In the course of my researches on the mammiferous ovum I have seen in the uterus of the Rabbit minute pellucid vesicles under the mucous membrane of that organ. These vesicles are frequent in that part of the uterus (under its mucous membrane) which joins the Fallopian tube. By enlargement they resemble ova; and the observer is sometimes not undeceived until he attempts to lift them from their situation. The uterus has generally been more or less highly vascular when the subject of my examination. Whether the vesicles in question present themselves in other states of this organ I do not know; but on the inner surface of what seemed one of

† pp. 97, 98.

those vesicles was seen a beautiful display of newly-formed vessels, in which the red particles of the blood were scarcely at rest, or at least were set in motion by the slightest descent of the compressorium. I have been ready to imagine that the origin of these vesicles in the uterus, and the phenomenon about to be recorded, may be connected with the formation of the blood-vessels and blood. The form of the vesicles in question is not regular; and I have observed an obscure appearance, possibly indicating a communication between their cavities and a more internal part.

282. Being engaged in laying open for examination the oviduct of a Rabbit, I found a little mass adherent to the instrument, which on being viewed in the microscope was found to be a detached portion of its inner membrane. Imbedded in this little mass was a vesicle (Plate IX. fig. 151.) of an ellipsoidal form, $\frac{1}{7}'''$ in length, consisting of a tolerably thick membrane, having on its inner surface a layer of elliptic granules (vesicles ?), and containing a pellucid fluid. This being apparently one of the vesicles in question, would not perhaps have been examined farther, but for a remarkable phenomenon observed in its interior.

283. In the centre of the fluid of the vesicle there was an object (see the figure) resembling the mulberry-like structure, which I have described in the mammiferous ovum (Plate VI. figs. 109 to 112.), actually *revolving on its own axis*. The revolutions were in the vertical plane, a direction which was not observed to change. In point of time they were not quite regular, being sometimes rapid, while at other times the object seemed nearly, though not quite at rest. Twice the revolving body was observed suddenly to shift its situation in the fluid, make a short circuit, and then almost immediately return to the centre of the vesicle. It had a diameter of $\frac{1}{50}'''$. Granules (vesicles ?) were occasionally seen to start from their situation in the layer lining the membrane of the vesicle, and move towards the centre of the fluid; but they were not observed to attach themselves to the revolving body.

284. The object was watched revolving for half an hour, at the end of which time its revolutions terminated rather suddenly. The little mass then for a few seconds seemed to be at rest. It next assumed a tremulous motion, which—interrupted for a few seconds by a renewal of the revolutions—continued for about fifteen minutes, making three quarters of an hour in all, during which the object was observed to be in motion. And it is deserving of remark, that the Rabbit had been killed an hour and half before the examination was begun. Having ceased to move, the little mass was broken up by the compressor, when some of its parts, still hanging together, presented a renewal of the tremulous motion just mentioned. During these observations ciliary motions were very vivid on the mucous membrane investing the vesicle in question. They had become languid when the revolutions ceased. No cilia were observed on the revolving object itself; but cilia may have been present, and from their minuteness invisible†.

† On the subject of cilia as a cause of rotatory motion, I refer to Professor SHARPEY's excellent paper in Dr. TODD's "Cyclopædia of Anatomy and Physiology," vol. i. p. 606.

285. I cannot better describe the appearance of the object now referred to as revolving on its own axis, than by stating that it would not have been easy to distinguish it from the mulberry-like structure (Plate VI. figs. 109 to 112.) occupying in certain stages the centre of the mammiferous ovum, and containing the structure which I consider to be the primordial germ. The revolving object in the vesicle (Plate IX. fig. 151.) was however smaller. The vesicles (fig. 152.) composing the surface of the mulberry-like structure in these vesicles vary in their size, many of them measuring $\frac{1}{2000}'''$. Among them I have repeatedly observed several globules, or rather vesicles, which appeared to have occupied the centre of the mass. They were larger than those at the surface, granulous, yellowish-brown in colour, and contained themselves a globule. In some instances I have observed the whole mulberry to be tinged yellowish-brown, the colour being deepest in the centre of its vesicles. The vesicles, it will be observed (fig. 152.), contain objects (nuclei?) in their interior.

286. The phenomenon of *rotation* of the central mass in these vesicles I have seen only once, but it has not been particularly sought for. Frequently, however, has the existence of such a mass been observed with the same mulberry-like form. And in repeated instances the vesicles of the mass, more or less separated, have exhibited the tremulous motion above mentioned. In one instance the motion was comparable to that observed in separate globules when in the neighbourhood of cilia in motion.

287. It has been remarked by Professor Burdach†, that "the mammiferous ovum, not only in its form, but also in its vital relations, resembles a hydatid." The resemblance, however, was probably not conjectured to be so very close as from the above facts it appears to be. (Compare Plate IX. fig. 151. with several of the figures in Plate VI.) It remains to be discovered whether the mulberry-like structure with its germ in the ovum of Mammalia, also performs rotatory motions. The thought that it may do so has naturally suggested itself, from the striking resemblance in form, composition, and locality‡ of that structure in the mammiferous ovum and the uterine vesicles in question.

288. It is known that the *embryos* of a number of Mollusca, as well as the *germinal granules* of some Polypes, &c., perform rotatory motions. We are indebted to Professor Grant for some very interesting facts on this subject. Several observers have noticed this phenomenon in the *ova*, or *yelk-ball*, of certain animals. An instance of its occurrence in the latter appears to have been observed by Leeuwenhoek in 1695, but the subject claimed little attention until revived by Carus and E. H. Weber. Carus§ has investigated the subject in Mollusca. With reference chiefly to the ob-

† *L. c.*, vol. ii. p. 820.

‡ It is not unusual to meet with vesicles in which the object in question appears to have left the centre of the cavity, and approached the membrane on one side (par. 185.).

§ Von den äussern Lebensbedingungen der weiss- und kaltblütigen Thiere, 1823; and Neue Untersuchungen über die Entwickelungsgeschichte unserer Flussmuschel, 1832.

servations of the last-named author, BURDACH† states the following regarding the ova of *Limnæus stagnalis.* "With the incipient formation and development of an embryo, the yelk-ball performs in the vertical plane [par. 283.] rotatory motions around its axis, the cause of which has not been satisfactorily explained. The yelk granules *swell,* and become large and *vesicular.* After some days the revolutions become weaker." Is it not possible, that the so-called "yelk" in this instance, the granules of which became "*vesicular,*" really corresponded to the mulberry-like structure I have met with in the ovum of Mammalia and in the vesicles just mentioned? CARUS‡ has mentioned rotatory motions as occurring in the ova of *Unio tumida.* These were horizontal, and accompanied by a change in the form of the yelk. The same observer saw in *Anodonta intermedia* corresponding motions, which were subject to temporary cessation, and the direction of which was irregular.

289. It is an interesting fact, that in two out of the three genera above mentioned —as affording examples of revolving ova—there has been observed a structure that appears to be essentially the same as that which I have met with in the ovum and the uterine vesicles in question of Mammalia, producing the appearance of a mulberry.

Correspondence in the Elementary Structure of Animals and Plants.

290. Few microscopic investigations have led to discoveries so interesting and important as those of SCHWANN§ on the correspondence in the structure and growth of animals and plants; and certainly no stronger proof can be required of the importance of the history of development to physiology. That author, basing his researches in the animal upon the discoveries of SCHLEIDEN|| in the vegetable kingdom, has demonstrated that in development the same phenomena are exhibited in both. He has shown not only that animal tissues in general, like those of plants, are reducible to modifications of vesicles, or as he calls them "cells,"—but that the mode of origin of the vesicles or "cells" is essentially the same in animals as SCHLEIDEN had discovered it to be in plants. The membrane of each vesicle or "cell" is formed at the surface of a previously existing nucleus, which is a minute, spherical, or elliptical, and often flattened body, having a granulous appearance, and found by SCHLEIDEN in many instances to contain a nucleolus¶. The membrane of the vesicle was found by SCHLEIDEN to rise from the nucleus, and in the early progress of distention to present an appearance which he compares to that of a watch-glass on a watch. The analogy now mentioned extends to organized as well as unorganized animal tissues; and even the blood-vessels are formed of vesicles or "cells." Farther, elementary parts, which in a physiological point of view are entirely different, have been shown by SCHWANN to

† *L. c.*, vol. ii. p. 224. ‡ Neue Untersuchungen, &c. § Mikroskopische Untersuchungen, &c.

|| "Beiträge zur Phytogenesis," in MÜLLER's Archiv, 1838. Heft II.

¶ The nucleus had been known to other botanists, its importance having been first conceived by our very distinguished countryman ROBERT BROWN; but its property of originating the "cell" was the discovery of SCHLEIDEN, who from this property proposes to denominate it the "*Cytoblast.*"

follow the same laws in their development. Thus whether a muscular fibre or a nervous tube is destined to be formed, the foundation of both consists of vesicles or "cells," which have arisen in the manner above described; and it is through the modifications which the vesicles undergo, that a muscular fibre on the one hand, or a nervous tube on the other, is produced. "In short, there is for all the elementary parts of organisms a common principle of development."

291. It will be interesting to refer to a few of the facts recorded in the foregoing and the previous memoir, in connexion with the analogy now mentioned; and if those facts should be found in any way to exemplify it, they will not be the less admissible from my having observed them in the course of researches in which this analogy formed no part of the object I was in pursuit of.

292. Both the nucleus and nucleolus were figured in my "First Series †," in the peculiar granules, or rather vesicles of the ovisac, though I was ignorant of their importance. It will be seen indeed that those peculiar granules (vesicles) form a part of more than fifty figures in that paper, and that the nucleus is represented in almost every instance where the size admitted of it. This is mentioned merely to show that those objects (the nucleus and nucleolus) were not overlooked, for to SCHLEIDEN belongs the merit of first pointing out the nature of those objects in plants, and to SCHWANN that of recognising corresponding structures in animals. That memoir contained also the drawing of a spot ‡ on the inner surface of the membrane of the yelk in the ovum of the Frog. Of that spot I did not attempt to offer any explanation, simply stating its appearance as "a spot which I always find on the internal surface of the membrana vitelli of the Frog in ovisacs of about this size [$\frac{1}{3}'''$]. This spot does not appear to have been hitherto described. It is generally elliptic, rarely round, has a well-defined contour, and is perhaps slightly lenticular in form. In this instance it measured $\frac{1}{75}'''$ in length, and is often of about the same size. It appears to be composed of granules §." The spot in question is obviously the nucleus of the membrane or vesicle on the inner surface of which it occurs ||.

293. The vesicles which constitute the outer portion of the mulberry-like structure (Plate VI. fig. 110., Plate VIII. fig. 130.) present each a nucleus ¶ and nucleolus.

† *L. c.*, Plate VIII. fig. 73.

‡ *L. c.*, Plate VI. fig. 28. d^1, and in the present paper, Plate V. fig. 84½. *x*.

§ *L. c.*, par. 40.

|| The existence of this spot will probably be found of some importance in determining the order of formation of the several parts of which the ovum is composed. And it is proper to state, that SCHLEIDEN's discovery in plants of the origin of vesicles ("cells") on a nucleus, and the extension of this discovery to animals by SCHWANN, must necessarily modify some of the conclusions in my "First Series" as to the order of formation here referred to; but in the present series this has not been the subject of investigation. I would remark, however, that if the spot on the inner surface of the membrana vitelli in the ovum of the Frog is present in the corresponding membrane of other ova, the formation of this membrane is doubtless earlier than that of the germinal vesicle itself (par. 242.). I have observed the stroma in the neighbourhood of an ovisac to appear as if composed of vesicles with nuclei.

¶ It is not probable, however, that the nucleus here referred to is of the same kind as that called the "Cytoblast" by SCHLEIDEN (see par. 317. and its last Note.).

294. The vesicles composing the layer (*am.*) on the inner surface of the membrane *f* (Plate VI. figs. 111 to 117., Plate VIII. fig. 129) have each their nucleus‡ and nucleolus. Hence the amnion—formed as it is out of these vesicles—may be added to the structures already found to be referable to a "cell"-formation.

295. The lamina in which I suppose the blood and blood-vessels to form, presented in its mode of origin a series of changes which do not seem to have been before observed in any animal, and it will be seen that they are most intimately connected with the present subject. (See par. 196. 197. 201 to 204. 211.).

296. The yelk-globules are true vesicles, containing other vesicles (Plate V. fig. 87.). The villi of the chorion are vesicles in which I observed objects having the appearance of vesicles (Plate VIII. fig. 141.). The whole embryo indeed is composed of vesicles (Plate VIII. figs. 121 A. 121 B. 122. bb^1. and bb^2.); and *even the primordial germ itself* (Plate VI. fig. 113. *bb.*) seems to have been the nucleus of the vesicle in the centre of which it lies†.

297. I have now to mention a fact or two regarding the nature and properties of nuclei. SCHLEIDEN supposes the nucleolus to exist before the nucleus, and SCHWANN believes that he has observed the formation of the nucleus to take place around the nucleolus. Hence the last-mentioned observer considers that it may be said, "the formation of the cell [vesicle] is only a repetition around the nucleus, of the same process through which the nucleus was formed around the nucleolus;" the difference being only in degree. In connexion with this view SCHWANN refers to the fact, that nuclei often become hollow vesicles. On the period of origin of the nucleolus I have no observations, except that its existence was not appreciable in any of the nuclei represented in Plate VII. figs. 120 and 121‡., and not in all of those in Plate VIII. fig. 150‡. Several observations, however, enable me to state that objects occupying the situation of nuclei are sometimes hollow vesicles. Such for instance was their condition in the amnion (Plate VIII. figs. 129. 130‡.) and in the lamina subsequently vascular (fig. 150‡.). I have also observed that with incipient decomposition of the peculiar granules (vesicles) of the ovisac, their nuclei appear like vesicles, filled with a colourless and pellucid fluid (Plate V. fig. 102. *g.*). Whether this results from distention of the nucleolus (frequently seen to be hollow), or from liquefaction of the contents of the nucleus including the nucleolus, I do not know.

299. The following observation (before noticed) may serve to extend our knowledge as to the properties of a nucleus. If Plate V. fig. 89. *b.* be referred to, it will be seen that the germinal spot (as such) has disappeared, and that in its stead are several vesicles with intermediate granules§. From those vesicles the germinal vesicle (*c.*) did not appear to differ except in its greater size. This was the effect of incipient decomposition. Here then the germinal spot (possibly, as supposed by SCHWANN, a

† See the first part of the Note to par. 186. ‡ See the Note to par. 293.

§ In the ovum Plate V. fig. 86. the same phenomenon was observed, though with less distinctness.

nucleus in reference to the germinal vesicle) was seen to have resolved itself into vesicles; a fact, which seems deserving of notice, as being the result of decomposition.

300. The primordial germ, as already stated, seems to be a nucleus. And here we find the most important of all nuclei resolving itself entirely into vesicles,—the first of these vesicles containing that which I have denominated the peripheral portion of the germ (Plate VIII. fig. 148. bb^2.). (See the *primitive* changes in the germ par. 209. 212 to 215. 312. and Plate VII. figs. 121 A. 121 B. 122.)†.

301. The vesicles exhibited in Plate VIII. fig. 149. constituted part of the incipient embryo in an ovum of $111\frac{1}{2}$ hours and measuring $\frac{1}{5}'''$. They were drawn after removal from their situation, and after the ovum had lain forty-eight hours in kreosote water. It will be seen that those vesicles contained two or even three minuter vesicles, inclosed the one within the other. The arrangement was not concentric, all the vesicles being in contact at a certain point, while on the other side there were intervening spaces. This was observed to be the case with the vesicles into which the germinal spot, above referred to, had resolved itself (Plate V. fig. 89. *b*.) from incipient decomposition.

302. In these researches no objects have so frequently been met with as those which I have called "dark globules." They present themselves with the earliest appearance of the ovum (Plate V. figs. 81 to 83.), and in many stages of its development. Wherever a part is beginning to be formed, or the formation is vigorously proceeding, there are seen dark globules. The yelk, the peculiar granules (vesicles) of the ovisac, and the villi of the chorion afford examples. They are present in very large quantity, among the vesicles of which the incipient embryo is composed (Plate VIII. fig. 149.); and here they appear to be no other than the foundations of new vesicles. (Compare the inner with the outer part of bb^1 in Plate VII. fig. 121 A.) I am disposed to think that this is the case in many other instances. For example, the vesicles destined to form the villi of the chorion arise in this manner (par. 223.); and the dark globules of the yelk we have seen to be true vesicles containing other vesicles (par. 121. and Plate V. fig. 87.).

303. The space between the membrane of an outer and the membrane of an inner vesicle (or nucleus) seems in many instances to be the place of origin of dark globules, or incipient vesicles‡. During the *primitive* changes in the germ (par. 312.)

† The resemblance in position and appearance between the germ (Plate VI. fig. 113. *bb*.) and the germinal spot after impregnation (Plate V. figs. 93 and 96 *b*.) is very remarkable. So great is this resemblance that at first I supposed and recorded it to be the germinal spot and vesicle again coming into view. And it has been only in consequence of my inability to discover these objects in intermediate stages (such as those represented in Plate VI. fig. $105\frac{1}{2}$ to 108.) that I have been induced to give up the opinion that the germinal spot is identical with that which I have called the germ; and to maintain (as I am compelled to do) that the germ is a new formation, not originating until after the ovum has been fecundated. The resemblance between the subsequent appearance of the germ, as composed of vesicles (Plate VII. figs. 121 A. to 122.), and the condition of the germinal spot when undergoing decomposition (Plate V. fig. 89. *b*.), is not less remarkable. (See, however, the first part of the Note to par. 186, and the Notes to par. 193 and 197.)

‡ In plants, according to Schleiden, the origin of vesicles within already existing vesicles is nearly or quite

an example of this occurs (Plate VII. figs. 121 A. to 123. bb^1.). Each of the concentric layers of which the germ consists, is so distinctly circumscribed as to appear delicately membranous at its surface (par. 212.); or in other words, each concentric layer appears to be contained within a vesicle. Now here, as just stated, the intervening spaces are occupied by dark globules, subsequently forming vesicles.

304. More particularly considered, the situation, and perhaps the place of origin of the dark globules in question, is in some instances *on the outer surface of the inner vesicle or nucleus*; of which Plate VIII. fig. 150. affords a remarkable example, in the lamina subsequently vascular†. The dark globules in the network Plate VIII. fig. 132. in every instance surround the nucleus†. The yelk-globules (vesicles) seem to arise on the outer surface of the germinal vesicle‡†. In other instances the foundations of new vesicles arise as dark globules on the external surface of an *outer* vesicle. This is the case with the vesicles forming the villi of the chorion (par. 223.); and perhaps the "isolated spots" occurring in the Graafian vesicle may be mentioned as another example§.

305. On the liquefaction of the membrane of a vesicle dark globules are sometimes liberated. This takes place, for instance, when the membranous portion of the network (composed of vesicles, par. 201.) Plate VIII. fig. 132. disappears. (See Plate VII. fig. 120. Whether the dark globules which the latter figure shows to have been set free, are the foundations of new vesicles, I do not know; but in an ovum of about the same size the corresponding part presented vesicles in such quantity as to be pressed together into polyhedral figures, Plate VIII. fig. 150. From some observations on the vesicles of which the incipient embryo is composed, I am disposed to think the dark globules exhibited in Plate VIII. fig. 149. (or a part of them) may have been liberated in the same manner.

306. In Plate VIII. fig. 143. is an ovum of twenty-three hours from the Fallopian tube. It was found with five others, and they were all lying very near together. These ova had penetrated about $\frac{1}{4}$ to $\frac{1}{2}$ an inch into that part of the tube where its calibre suddenly diminishes; a part which when rolled between the fingers is found to resemble the vas deferens. In this ovum (fig. 143.) the chorion had not separated

---

universal. In the formation of animal tissues, on the other hand, SCHWANN found this to be rarely the case. The observations, however, now referred to, of the origin of vesicles in vesicles, relate to a period anterior to the formation of even the elementary parts of tissues (nervous tubes, muscular fibres, &c.), and therefore are not necessarily opposed to those of SCHWANN.

† See the Note to par. 293.

‡ See my "First Series," *l. c.*, Plate V. figs. 14 and 16. It is interesting to find, as already stated, not only that the *formation*, but also that the *liquefaction* of the yelk-globules (vesicles) begins around the germinal vesicle (Plate V. figs. 99 and 100.).

§ These "isolated spots" were described in my "First Series" (par. 59. Plate VIII. fig. 66.) as consisting "of one of the peculiar granules [vesicles] of the Graafian vesicle, having a peripheral accumulation consisting of oil-like globules."

from the membrane *f*, but it was visible as a dark line surrounding the latter. (See also Plate VI. fig. 104. *α*.) The membrane *f* contained two objects measuring respectively $\frac{1}{33}'''$ and $\frac{1}{28}'''$ in length †. Those objects had the appearance of two yelk-balls, and I am by no means sure that this was not the case. It seems possible, however, that they arose from a division of the previous yelk-ball into two portions. If so, this ovum was in a stage between that represented in Plate VI. figs. 105 and 106 ‡. The resemblance it bears to the ovum of Batrachian Reptiles after the first division of the yelk has taken place is remarkable §, and favours the latter supposition. Having met with but a single ovum in this state, however, I must leave this question for future observation to decide. In each of the two objects present in the ovum now referred to (Plate VIII. fig. 143.) there was observed a brilliant point.

307. The stages of the mammiferous ovum, exhibited in Plate VIII. figs. 106 to 108. presenting as they do successive sets of vesicles, each set consisting of smaller and more numerous vesicles than the last, suggest the idea that in the interior of each vesicle there arise two or more infant vesicles, the parent vesicle in each instance disappearing by liquefaction. Those later stages also bring to mind the divisions and subdivisions first observed by Prevost and Dumas in the ovum of Batrachian Reptiles, and since found by Rusconi to occur in some osseous Fishes; suggesting also that these divisions and subdivisions may be referable to the formation of vesicles ‖. Rusconi observed in the ovum of the Frog that some of the masses

† The *yelk-ball* in the other ova found at the same time had a diameter in one instance of $\frac{1}{10}'''$, and in another of $\frac{1}{17}'''$.

‡ It will be observed that the ovum Plate VIII. fig. 143. is exhibited on a larger scale than the ova in Plate VI. fig. 105 and 106.

§ Compare Plate VIII. fig. 143. with figures by Rusconi of the ovum of the Salamander and the Frog (Müller's Archiv, 1836. Heft II. Tab. VIII.).

‖ Schwann, without knowing of the formation of the vesicles which I have described in the centre of the mammiferous ovum, conjectured that possibly the divisions in the ovum of the Frog, &c. might be reducible to a formation of vesicles; "two vesicles first developing themselves within the yelk, in each of the same two new vesicles, and so on." (*l. c.*, pp. 61. 62.). Bischoff after observing the yelk to have, as he supposed, an "angular" appearance in the ovum of the Dog, proceeds, "I have sometimes seen forms so remarkable, that the thought occurred to me, whether the yelk of the mammiferous ovum also undergoes changes in form similar to those in the ova of Fishes and Batrachians. But unfortunately these forms of the yelk are very soon lost, as soon as the ovum is placed in water or saliva, probably through imbibition of this fluid. Hence I have not been able to note some of them." (*l. c.*, p. 96.) It appears to me, that what Bischoff here terms "remarkable forms of the yelk" must have corresponded to my mulberry-like structure in its different stages.—That observer concludes the account of his researches with the following remarks. "Putting together my more recent with the earlier observations, I think the process of the formation of cells is the following: the yelk-granules first group themselves in smaller globular masses [nuclei], which then become surrounded by a cell. With the growth of the cell the granules separate from one another, group themselves in concentric rings, and now the nuclei become new cells, until at last each yelk-granule is surrounded by a cell, and the germinal membrane is so formed as in figs. VII. and VIII., where each cell contains a simple nucleus. In figs. IV. and V. the cells are still few, and hence there are many granules in each; in fig. VI. there are already more vesicles and the granules are fewer; in figs. VII. and VIII. the cells are still more numerous and each contains only one

(vesicles?) resulting from the divisions and subdivisions, presented cavities in their interior. Von Baer† and Rusconi‡ have both figured a flattened "cavity" in the ovum of the Frog on that side where the divisions and subdivisions (i.e. the formation of vesicles?) had most rapidly proceeded. Does this "cavity" correspond to my vesicle which contains the germ§?

Anomalous Ova.

308. The object represented in Plate VIII. fig. 144. was found with four ova in the uterus about $\frac{3}{4}$ inch from the Fallopian tube. The period was $111\frac{1}{2}$ hours. The ova measured about $\frac{1}{3}'''$; the object in question $\frac{1}{11}'''$. The latter consisted of the following parts; viz. an outer membrane (*f*), resembling the thick transparent membrane ("zona pellucida") of the ovarian ovum; an inner pear-shaped membrane (*e*), $\frac{1}{20}'''$ in length, having considerable thickness; and in the interior of this second membrane, two vesicles, one of which measured $\frac{1}{50}'''$, the other $\frac{1}{30}'''$. The membranes of these two vesicles also had considerable thickness. All the membranes were transparent, and contained a colourless transparent fluid. The two smallest vesicles presented a mass in their centres having a granulous appearance. I am disposed to think this object was an ovum, but it is not easy to determine the nature of its parts‖. On another occasion I found in the uterus an object of $\frac{1}{6}'''$ resembling the above, but the second membrane (*e*) was not present.

The origin of Tissues subordinate to a division into forms.

312. It will be remembered that the germ when first seen has the appearance of a granulous thick-walled hollow sphere, containing a brightly pellucid fluid (Plate VI. fig. 113. *bb*.), and that this object having separated into two portions (Plate VIII. fig. 148. bb^1 and bb^2.), the central portion undergoes the following changes¶. It presents a pointed process (Plate VII. fig. 118. bb^1.), and resolves itself into vesicles,

---

nucleus. If we would extend this process still farther, the changes in form of the yelk are indeed so determined, that in the first place all the yelk-granules are inclosed in two, then in four, then in eight, &c. cells, until each yelk-granule has its cell and *therewith the germinal membrane is formed until the arising of the embryo.* The cells are besides of different sizes; in figs. IV. and V. most of them measured 0,0014 to 0,0018 Par. inch, but some only 0,0008 Par. inch." (*l. c.*, pp. 100, 101.). (See par. 314 to 317.)

† Müller's Archiv, 1834, Heft VI. ‡ *Ib.* 1836, Heft II.

§ Should the analogy in question really exist, it will prove that Rusconi was correct when he stated, in opposition to the opinion of Baer, "that the furrows in the ovum of the Frog are the *effect* of impregnation, and not the means by which impregnation is facilitated." (Müller's Archiv, 1836, Heft II. p. 208.)—R. Wagner adopts this opinion of Rusconi (Lehrbuch, &c.).

‖ Farther observations have satisfied me that this was an ovum aborted in a stage between the conditions represented in Plate VI. figs. 105 and $105\frac{1}{2}$ (see par. 317. *Note.*). The other object above mentioned as measuring $\frac{1}{6}'''$, appears to have been an ovum aborted in the state represented in Plate VI. fig. $105\frac{1}{2}$. In neither of these ova had the chorion arisen.

¶ See, however, the Notes to par. 193 and 197.

which are disposed in layers (figs. 121 A. to 122 bb^1.). Layer after layer comes into view in the interior (each layer appearing as if invested by a delicate capsule), while those previously occupying that situation are pushed farther out. These changes may be called *primitive*†, for at a certain period no more layers make their appearance, and the cavity inclosed by the most central layer becomes enlarged. It is very interesting to observe, that before those *primitive* changes have reached their limit, a structure is produced (by the layers of vesicles in question) having the *form* of the central portion of the nervous system, including even the sinus rhomboidalis of the spinal cord‡. It is also interesting to find that the foundation of the vascular system is a part of the primordial germ (par. 216.). The nature of the alterations which the germ undergoes immediately after the termination of the primitive changes now referred to, I do not know, not having carried my investigations beyond that period. It is probable that they consist chiefly in the formation of new vesicles. The object represented in figs. 125 and 126.—met with incidentally—was in a much more advanced state as to *form*, and exhibited an incipient division into further forms (par. 218.); yet it presented no trace of separation into tissues. *The origin of tissues, then, is subordinate to a division into forms.* This may serve to elucidate the fact, that parts in different animals, having a general resemblance in *form*, are sometimes the seat of very different *functions*. And if the primordial germs of organized beings in general resemble one another in appearance, as much as, from my observations, it appears that they do in some instances very remote from one another, it is not surprising that there exist resemblances in the subsequent *forms* of beings more nearly allied. I refer, for example, to a curious resemblance between the mammiferous germ with its vesicle—as exhibited in Plate VI. fig. 113.—and the "cytoblast" and spore of a cryptogamous plant (*Rhizina lævigata*),—as figured by Schleiden in his paper on vegetable structure§. This observation will perhaps be considered as not undeserving of notice in connexion with the subject of analogies in the fundamental structure of organized beings. We find also, that there is a period in the formation of the Mammal —and therefore, it may be presumed, of Man himself—when the immediate foundation of the new being is contained within a simple "cell," vesicle, or sac.

Method of obtaining the minutest Ova in the Uterus and Fallopian Tube; and a mode of preserving them while under examination.

313. The almost entire absence heretofore of observations on the smallest ova in the oviduct of the Mammalia, may be attributed to the difficulty experienced by ob-

† The separation of the germ into a central and a peripheral portion being the first of these *primitive* changes.

‡ I apprehend it would be an error to suppose that the fluid contained within a tube is the first appearance of the central portion of the nervous system. Its original foundation seems to be present from the first; and its form, as above stated, is seen before that of any other part. The object represented in Plate VII. figs. 125 and 126.—and more particularly its inner part—I am disposed to think consisted chiefly of the foundation of the central portion of the nervous system.

§ *L. c.*, Tab. III. fig. 11.

servers in obtaining objects so minute, and to their inability to apply to those delicate objects—when found—an equally delicate manipulation. My own efforts were for a long while nearly fruitless from the same causes (par. 166.). But experience having at length enabled me to surmount in some degree those difficulties, I will describe the means by which this may be accomplished. Before commencing the examination I provide several discs of glass, of about the diameter and thickness of a small wafer. Some easily compressible *oily* substance—I employ glaziers' putty—is then rolled out into the form of a slender thread, and a portion of it in this state formed into a ring upon each of the glass discs, in such a manner that a closed cavity may be produced in the centre when the disc is inverted and placed upon a plane surface.—The *Uterus*. Having laid open its cavity, and ascertained, by a careful inspection of its walls, that the ova are not visible with the naked eye, or by means of a pocket lens,—I proceed to remove successive portions of the mucus, beginning with the surface nearest to the Fallopian tube. This is done by scraping it off in small quantities with a broad scalpel, the mucus so removed being carefully transferred to a piece of glass. If this glass be held up to the light and examined with a lens, the observer at once detects an ovum, if present, from its peculiar appearance as a pellucid point, distinguishable from a bubble of air or a globule of oil, by the small refraction of light which occurs at its surface, when viewed in such a medium. If the quantity of mucus which lies above the ovum be too great, it may be removed with a very fine hair pencil, care being taken to avoid touching the ovum itself. A disc of glass furnished with its ring of putty above described, is now to be inverted over the mucus, and slight pressure used. A closed cavity is thus made, which is so minute that in a cool atmosphere no sensible evaporation can take place, and the ovum may be viewed for a considerable time in a nearly unchanged state. The object in having the upper glass *thin*, is to admit the use of magnifying powers having a short focal distance. From the yielding nature of the putty, a compressor—if required—is thus ready formed.—The *Fallopian tube*. The following passage occurs in the paper, before referred to, of the indefatigable Cruikshank†: "Searched in vain for the ova on the right side; at last, by drawing a probe gently over the Fallopian tube on the left side, before it was opened, more than an inch on the side next the uterus, I pressed out several ova, which seemed to come from about its middle, as I began the pressure there, and the ova did not appear till the very last." Yet Cruikshank himself seems not to have applied this method in any other instance, for he subsequently mentions that some of the ova of another Rabbit "were lost from the great difficulty in slitting up the Fallopian tubes without bruising the ova with the fingers or with the point of scissors‡." To the casual mention by Cruikshank, of an alternative resorted to by him on one occasion,—which seems to have remained unnoticed for nearly half a century,—I am indebted for a mode of obtaining ova from the Fallopian tube, that—with some modifications—I now always practise; and which, had I used it from the first, would have enabled me to include in the

† *L. c.*, p. 208, Experiment XXIII.

‡ *L. c.*, p. 208.

Table hereafter given (par. 319.) a much larger number of ova from that narrow passage. I never lay the tube open. Having with fine scissors removed all the adherent substance,—taking care not to apply pressure to the tube at any part,—I extend it in its whole length, divide it in the middle, and proceed to examine the uterine or ovarian half, according to the age of the ova. This is done by cutting off a small portion—say half an inch—of the unopened tube, and pressing out its contents upon a piece of glass with a scalpel. (It is probable that some ova are thus destroyed. But this is of no consequence at all, when we recollect the time saved, and the difficulty in obtaining ova by any other means.) The glass containing the mucus from the portion of Fallopian tube, is then to be held up to the light and examined with a lens as before. If from the minuteness of the ova a lens is insufficient, the mucus may be examined in the microscope with a low power,—say twenty-five diameters,—when the ova if present cannot fail to be detected, whatever their minuteness. It not unfrequently happens that several present themselves in the same field of view. When the mucus is found to contain an ovum, the little disc of glass with its plastic ring should be *instantly* applied, to prevent evaporation†.

Second Postscript.

Process by which the primitive Ovum undergoes Division and Subdivision.—Probable Analogy in this respect between the Mammiferous Ovum and the Ovum of Batrachian Reptiles and certain Fishes.—The so-called "Yelk-ball" in the Mammiferous Ovum compared with the "Discus vitellinus" in the Ova of other Animals.—Resemblance between the fecundated Ovum of Mammalia and that of certain Plants.

314. In reference to the mode in which the successive groups of vesicles are produced in the centre of the ovum during its passage through the Fallopian tube, I ventured to suggest (par. 307.) "that in the interior of each vesicle there arise two or more infant vesicles, the parent vesicle in each instance disappearing by liquefaction." Such really is the case, as proved by the condition of ova which I have met with since.

315. In Plate VI. fig. $105\frac{1}{2}$ is exhibited an ovum of twenty-four hours (from the Fallopian tube), which in reference to its central part was in a condition between the stages seen in figs. 105 and 106‡. The "yelk-ball" (fig. 105.) having—as such—disappeared, *two* vesicles (fig. $105\frac{1}{2}$.) occupied its place; and in another ovum, instead of two corresponding vesicles, *four* (fig. 106.) were found in the same situation.

† Care must be taken that the surface of the glass is dry, and that none of the mucus insinuates itself under the putty. I have in more than one instance preserved the ovum in cold weather for a length of time, which far exceeded expectation. The distance between the two glasses should little exceed the diameter of the ovum, by which the included air is reduced to a very minute quantity.

‡ The chorion was less advanced than in the ovum fig. 105.

316. Each of the *two* vesicles in the centre of the ovum (Plate VI. fig. 105½.) was elliptical and flattened, highly transparent, exhibited a very sharp black contour, and contained a transparent fluid, granules, and a spherical pellucid object having a central situation†. A description in many respects the same has been given (par. 174.) of the *four* vesicles in fig. 106.

317. "That in the interior of each vesicle there arise two or more infant vesicles," we have a proof in Plate IX. fig. 155. Here two outer vesicles are seen corresponding to the two which occupied the centre of the ovum Plate VI. fig. 105½‡. The age of the ovum Plate VI. fig. 105½. was 24 hours; that of the one from which Plate IX. fig. 155. was taken, 26¼ hours. In each of the two vesicles occupying the centre of the ovum Plate VI. fig. 105½. there were seen (as already stated) granules and a central pellucid sphere; while each of the corresponding vesicles in Plate IX. fig. 155. presented in its interior formed *vesicles*. There can be no doubt that the ovum, the central part of which is represented in Plate IX. fig. 155, was in a state between the conditions of the ova in Plate VI. figs. 105½ and 106; and it is extremely probable that before the production of the state seen in Plate VI. fig. 106, the membranes of two vesicles, such as the outer ones in Plate IX. fig. 155, usually disappear by liquefaction. This process continued, would produce successively states such as those in Plate VI. figs. 107 and 108§; and perhaps it would not be easy to point out the period of its termination.—The position which the germinal vesicle should be considered to occupy in the history of "cells," remains a question not yet solved. If a "Cytoblast" (par. 290. and its last Note), corresponding to that which I find on the vitellary membrane in the ovum of the Frog, is originally present in the ovum of other animals (par. 292. and Note), the germinal vesicle is obviously an infant "cell" in reference to the vitellary membrane (*f*.). But we have seen that in the mammiferous ovum a membrane (*e*) forms around the "yelk," in the same manner apparently as in other situations a membrane or "cell" forms around its nucleus. Now it is known that the germinal vesicle exists before the granules and globules of the "yelk;" those granules and globules collecting and perhaps forming around the germinal vesicle. If, therefore, the "yelk" be a nucleus to the membrane *e*, the germinal vesicle may, perhaps, be considered a *nucleolus* to the "yelk." This would afford an instance of a "cell" (the germinal vesicle) which had probably arisen from a "cytoblast" (the germinal spot), becoming in its turn a nucleolus for the formation of another "cytoblast" (the yelk), which then originates another "cell" (the mem-

† These pellucid objects from some cause very soon disappeared, and the two vesicles containing them became comparatively opake. This I have found to occur in many ova of the same period, as well as in ova of the succeeding stages; though no pressure had been applied. The vesicles occupying the centre of ova in a stage approaching that in Plate VI. fig. 108., for instance, at first highly transparent, speedily became opake, and seemed to collapse from a spherical into a polyhedral form.

‡ In some instances the difference in size of these vesicles is considerable.

§ The ingenious speculations of Schwann and Bischoff (par. 307. *Note*.), seem thus in some degree to have been realized.

brane *e*). Within the parent "cell" or membrane *e* new vesicles arise†; the interior of each of these in its turn presenting others. How far the process forming these new vesicles resembles that just referred to as appearing to produce the parent "cell" or membrane *e*, must be left for future observation to decide. We cannot but observe, however, a resemblance between the contents of the infant and the parent "cell"; a resemblance the more interesting from the long line of objects through which it seems traceable in direct succession from the ovum‡.

318. We are now perhaps prepared to realize an analogy already hinted at (pars. 177. 307.), between the early changes which I find to occur in the mammiferous ovum and those previously known to take place in the ovum of Batrachian Reptiles, and some osseous Fishes. The divisions and subdivisions occurring in the ova of these animals, may be effected by a process corresponding to that just described as producing similar changes in the ovum of the Mammal. And if in the former no "outer vesicle" nor pellucid sphere has yet been seen, or suspected, to arise and then disappear between each division, this affords no proof of the non-existence of such objects,—which possibly may yet be discovered. In Fishes the divisions in question do not include the whole yelk-ball, but are confined to a projection on one side§. In the Frog those divisions include the whole of the yelk-ball, but they begin, and proceed more vigorously, on one side‖. In Mammalia also, as we have seen, the divisions include the whole of the so-called "yelk-ball." This comparison may perhaps assist us in

† The aborted ovum, Plate VIII. fig. 144, exhibited what I apprehend to have been the membrane *e* risen in the above manner (at the surface of the "yelk-ball"), but which did not disappear by liquefaction, and was persistent (considerably thickened) until two vesicles had been formed within it (and likewise thickened), each of these presenting a granulous mass in its interior.

‡ Where, indeed, does this resemblance terminate? We find that it has by no means disappeared in the "cells" (Plate VIII. figs. 130. 129.) which seem to enter into the formation of the amnion, nor in those of the lamina subsequently vascular (figs. 132, 150.); and an eminent observer—Valentin—has pointed out a resemblance still more remarkable between the ovum and his "Bildungskugeln" in various parts of the nervous system (Ueber den Verlauf, &c., pp. 146, 147. tab. VII. to IX.). The germinal vesicle-like objects in Plate VI. figs. 120. 121., Plate VIII. figs. 129. 130. 132. and 150.—called "nuclei" in the foregoing memoir—I am disposed to think are really *nucleoli*, for the reason above given regarding the germinal vesicle itself; the granules or globules surrounding them (Plate VIII. figs. 130. 150.) being perhaps the remains of a nucleus, in other instances (figs. 129. 150.) dissipated. We find also that in those germinal vesicle-like objects a minute point, —probably a "cytoblast"—was present in some instances, and had been absorbed (?) in others (par. 318. *Note.*).

§ As observed by Rusconi in the Tench and Bleak (*Cypr. Tinca* and *alburnus*). Müller's Archiv, 1836, Heft III. and IV. Tab. XIII.

‖ Von Baer, Müller's Archiv, 1834, Heft VI. Tab. XI. Rusconi, Müller's Archiv, 1836, Heft II. Tab. VIII. In connexion with this subject it is interesting to notice the situation of the germinal vesicle, when last seen, in the ovum of the Frog. It lies under the black layer, where—as a flaccid and flattened object —it occupies nearly half of the entire ovum. (See a very mature ovarian ovum of the Frog represented by R. Wagner (Beiträge, &c., Tab. II. fig. 6. *d.*), in which the germinal vesicle had become much enlarged.) Now it is in this part of the ovum of the Frog that the divisions above referred to commence and most vigorously proceed. (Rusconi, Müller's Archiv, 1836, Heft II. Tab. VIII. Baer, Müller's Archiv, 1834, Heft VI. Tab. XI.) See also what has been above stated regarding the projection, and the divisions occurring in this projection only, in the ovum of certain Fishes.

determining what portion it is of the ova of the animals just mentioned which corresponds to the "yelk-ball" in Mammalia. Is not the "discus vitellinus" in the *ovarian* ovum of the Bird the seat of similar divisions†? If so, it will perhaps appear that the so-called "yelk-ball" in the mammiferous ovum corresponds more particularly to the "discus vitellinus" (with its germinal vesicle) in the ovum of the Bird (par. 122. and *Note*. par. 174. and first Note.)‡.

† Do they not occur in the corresponding parts of ova in general?

‡ If the contents of the ovarian vesicle of Baer in Mammalia correspond to no more than the "discus vitellinus" in the ovarian ovum of Birds and other animals, the former will not appear to be relatively so minute as hitherto supposed. As to the difference in form of these two objects, perhaps a globular form of the substance composing the "discus vitellinus" would have been incompatible with its position under the vitellary membrane and with the presence around it—in the ovum of the Bird for instance—of a large quantity of true yelk, provided for a future purpose; while no such provision being required in the ovum of the Mammal, the substance corresponding, as I suppose, to the "discus vitellinus" of other animals fills the vitellary membrane (*f*), and is therefore globular in form. If the analogy in question really exists, the "discus vitellinus" is obviously a nucleus destined to undergo changes like those occurring in the so-called "yelk-ball" of the Mammalia. The round white spot called the "cicatricula" in the Bird's *laid* egg may possibly correspond to my layer of "cells," Plate VI. figs. 111 to 113, lining the vitellary membrane (*f*) in the *uterine* ovum of the Mammal; while my "mulberry-like object," in the same figures, may perhaps be represented in the Bird's *laid* egg by the structure which lies under the "cicatricula," and has been denominated Keimhügel, cumulus proligerus, Kern des Hahnentrittes, nucleus cicatriculæ s. blastodermatis, &c.

In reference to the subject of par. 317. and its last note, it may be added, that my view of the germinal vesicle as a *nucleolus* accords with the experience of Schleiden and of Schwann, that the nucleolus exists before the nucleus (par. 297.). The opinion expressed in the last note to par. 317, that the germinal vesicle-like objects called "nuclei" in the foregoing memoir are in strictness *nucleoli*, is applicable to the corresponding objects in previous conditions of the ovum;—for instance, in such as that exhibited in Plate VI. fig. 105½. Each of the twin "cells" here seen contained a *single* germinal vesicle-like object. In an ovum rather more advanced, but not yet in the state Plate IX. fig. 155, I saw *two* such germinal vesicle-like objects in the same twin "cell." And there seems to be a period in the life of each "cell" (Plate VI. figs. 105½, 106, 107, 108.) when the single germinal vesicle-like object disappears. Do two or more (the nucleoli of new and infant "cells") then arise as its successors? In two instances germinal vesicle-like objects were observed in a state of the ovum resembling that in Plate IX. fig. 155.; and one or two of them presented a dark point, which possibly was a germinal spot-like "cytoblast." Valentin compared an object observed by him in his "germinal vesicle-like nuclei" to the germinal spot. In one instance (Ueber den Verlauf, &c. tab. IX. fig. 73.) he has figured this object as surrounded by a circle. Had the circle been produced by a process of the same kind as that which effected the change in the germinal spot itself, seen in Plate V. figs. 89 *b*. (par. 124. 299.)? The fact that the germinal spot becomes hollow in certain states (Plate V. figs. 89, 93, 97, 102 *b*.) is interesting in connection with the experience of Schwann (regarding other "cytoblasts") referred to in par. 297.—The layer of "cells" lining the membrane *f*, not yet present in the ovum Plate VI. fig. 110, had made its appearance in the ovum fig. 111. Perhaps the "cells" of that layer arose from a continuation of the same process of division referred to in par. 317. (Two germinal vesicle-like objects (nucleoli) it will be remembered (par. 180.) were seen in one of the "cells" fig. 110.) If so, it may be asked,—in connection with what we have seen to take place within the parent cell (the membrane *e*),—does not this process of division admit of a more extended application in the history of "cells," than merely to the "cells" which are the immediate successors of the parent "cell" or membrane *e*? It is extremely interesting to find apparently the same process in operation at a corresponding period in the fecundated *vegetable* ovum. Such at least is the inference I draw from the delineations given by Schleiden (Wiegmann's Archiv, 1837, Tab. VII.; and London and Edinburgh Philosophical Ma-

319. *Ova found in the Fallopian Tube and Uterus of the Rabbit.*

The following Tables may, perhaps, facilitate the discovery of the minuter ova in the Rabbit by affording a general idea of their locality and size at different periods. But they also serve to show that in both of these respects the ova of different individuals are subject to variation, partly occasioned, perhaps, by differences in the degree of advancement in the rut. They farther show that there frequently exist considerable differences in the size and condition of ova destined to constitute the same litter of young; that there is no fixed relation between the size of the minuter ova and the degree of their development or their locality; and lastly that ova are not unfrequently aborted.

Ova found in the Fallopian Tube of the Rabbit.

Hours *post coitum.*	Number of ova found.	Diameter in fractions of a Paris line.	Condition.	Locality.
Hours. 10	2	$\frac{1}{15}$ and $\frac{1}{12}$	Third stage	One inch from the infundibulum.
17	6	$\frac{1}{14}$ to $\frac{1}{10}$	Varying from stage three to the condition represented Plate IX. fig. 153.	Near the middle of the tube.
23	6	$\frac{1}{12}$ $\frac{1}{14}$ to $\frac{1}{12}$	Plate VIII. fig. 143. Various stages..................	Where the tube suddenly diminishes in its calibre.
24	4	$\frac{1}{12}$ to $\frac{1}{11}$	Plate VI. fig. 105$\frac{1}{2}$	Middle of the tube.
26	5	$\frac{1}{11}$ to $\frac{1}{10}$	Plate IX. fig. 155. Apparently aborted.............	Ovarian side of the middle of the tube.
26$\frac{1}{4}$	4	$\frac{1}{10}$ to $\frac{1}{8}$	Plate IX. fig. 155, and Plate VI. fig. 105$\frac{1}{2}$	Ovarian side of the middle of the tube.
34$\frac{1}{4}$	13	$\frac{1}{10}$ to $\frac{1}{9}$	Various stages.	From the middle of the tube to within $\frac{1}{2}$ an inch of the uterus.
35$\frac{3}{4}$	6	$\frac{1}{10}$ to $\frac{1}{8}$	Fifth and sixth stages.	Between the middle and the uterine extremity of the tube.
41	3	$\frac{1}{12}$ — to $\frac{1}{12}$	Fourth stage.	Throughout the tube.
44$\frac{1}{4}$	9	about $\frac{1}{8}$	Eighth stage.	Near the middle of the tube.
47$\frac{1}{2}$	7	$\frac{1}{11}$ to $\frac{1}{8}$	The central portion of the ovum in the seventh and eighth stages. The chorion in the fifth stage, and in one instance still less advanced	Uterine side of the middle of the tube.
48	14	$\frac{1}{8}$ to $\frac{1}{7}$	Between eighth and ninth stages	Near the middle of the tube.
63	1	$\frac{1}{7}$	Ninth stage.........................	One inch from the uterus.
63	4	$\frac{1}{8}$	Fifth stage	Middle of the tube.
65$\frac{1}{2}$	2	$\frac{1}{11}$ and $\frac{1}{10}$	Second stage	Two inches from the uterus.
68$\frac{3}{4}$	7	$\frac{1}{7}$ to $\frac{1}{5}$	Tenth stage........................	$\frac{3}{4}$ inch from the uterus.
	93			

gazine, vol. xii. 1838, Plate 3.) of the incipient "Embryo" in several plants. The resemblance between those delineations and certain states of the mammiferous ovum in the Fallopian tube is very striking; and it is one for observing which I believe no previous opportunity has been afforded. With my drawings Plate VI. figs. 105.

Some of the Ova found in the Uterus of the Rabbit.

Hours *post coitum.*	Number of ova found.	Diameter in fractions of a Paris line.	Condition.	Locality.
Hours.				
$79\frac{1}{2}$	4	$\frac{1}{7}$	Eleventh stage....................	Near the tube.
86	9	$\frac{1}{6}$ to $\frac{1}{4}+$	Twelfth and thirteenth stages	Within an inch of the tube.
$94\frac{1}{2}$	4	$\frac{1}{6}$ to $\frac{1}{5}$	Twelfth, thirteenth, and fifteenth stages	Near the tube.
95	4	$\frac{1}{6}$ to $\frac{1}{4}+$	Two in the eighteenth stage	Near the tube.
$97\frac{3}{4}$	6	$\frac{1}{10}$, $\frac{1}{9}$	Aborted	Near the tube.
		$\frac{1}{7}$ to $\frac{1}{5}$	Sixteenth and seventeenth stages	
$102\frac{1}{2}$	9	$\frac{1}{7}$ to $\frac{1}{4}$	Thirteenth to seventeenth stages	Throughout the uterus.
103	13	$\frac{1}{4}$ to $\frac{2}{5}$	Sixteenth, nineteenth, and other stages	Near the tube.
105	4	$\frac{1}{7}$ to $\frac{1}{3}$	Fourteenth, and other stages........	$\frac{3}{4}$ inch from the tube.
$107\frac{1}{2}$	9	$\frac{1}{4}$ to $\frac{3}{4}$	Twenty-first, and other stages	All within one inch of the tube.
$107\frac{1}{2}$	6	$\frac{1}{8}$	Probably aborted..................	Near the tube.
		$\frac{1}{3}-$ to $\frac{1}{2}$	Twentieth, and other stages	
$108\frac{1}{2}$	10	$\frac{1}{4}+$ to $\frac{1}{2}+$	Nineteenth, and other stages........	Throughout the uterus.
$111\frac{1}{2}$	8	$\frac{1}{4}+$ to $\frac{1}{2}$	Twenty-first stage	Near the tube.
$112\frac{3}{4}$	1	$\frac{1}{2}$	?	Near the tube.
$114\frac{1}{4}$	7	$\frac{1}{4}+$ to $\frac{1}{2}$	Twenty-first, and other stages	Near the tube.
$114\frac{1}{4}$	9	$\frac{1}{7}$ to $\frac{1}{4}$	Apparently aborted...............	Throughout the uterus.
$115\frac{1}{2}$	5	$\frac{1}{7}$ to $\frac{1}{5}$	Aborted	Near the tube.
$115\frac{1}{2}$	9	$\frac{1}{11}$	Aborted. See Plate VIII. fig. 144	Near the tube.
		$\frac{1}{3}-$ to $\frac{1}{3}$	Various stages....................	
$115\frac{3}{4}$	9	$\frac{4}{10}$ to $\frac{7}{10}$	Some in nineteenth stage, others much more advanced	Throughout the uterus.
118	7	$\frac{1}{7}$	Apparently aborted...............	Throughout the uterus.
		$\frac{1}{5}$ to $\frac{5}{11}$	Various stages....................	
119	10	$\frac{2}{5}$ to $\frac{3}{4}$	Various stages....................	Throughout the uterus.
$120\frac{1}{2}$	5	$\frac{1}{7}$ to $\frac{1}{6}$	Aborted	Upper half of uterus.
$124\frac{1}{4}$	6	1 to $1\frac{1}{4}$	Stages later than the twenty-first	Upper half of uterus.
$131\frac{3}{4}$	9	$\frac{1}{8}$ and $\frac{1}{3}$	Probably aborted..................	Upper half of uterus.
		$\frac{2}{5}$ to 1	Various stages....................	
	163			

$105\frac{1}{2}$. 107. 108. respectively, I would compare those of Schleiden figs. 14. 15. (*Œnothera crassipes*) figs. 6. 7. (*Potamogeton lucens*). My figure Plate VI. fig. $105\frac{1}{2}$. shows the foundation of the mammiferous embryo to consist at a certain period of two "cells." According to Schleiden's representation (*l. c.* fig. 15.) such is the case in *Œnothera crassipes*; and here the two "cells" have the same form and general appearance as in the ovum of Mammalia, though germinal vesicle-like objects are not present. The evanescent nature of the latter (already mentioned) may possibly explain their absence in the vegetable figure. Some of my delineations of stages rather more advanced may perhaps admit of comparison with those of Schleiden, in which the "terminal shoots" (*punctum vegetationis* of Wolff) come into view, and the cotyledons begin to make their appearance. The granulous appearance in the interior of the "cell" *e* in certain stages, and in that of its

320. *Table of Measurements.*

The measurements are given in fractions of a Paris line ('''), the micrometer used, one of Frauenhofer's, being divided according to French measure. The French inch (of twelve lines) is to the English inch, as 1·06575 is to 1·00000, or nearly one fifteenth more. Assuming it to be exactly one fifteenth more, the simplest mode of converting the fraction of a French *line* into the fraction of an English *inch*, will be to multiply the denominator of the former by the number 11·25 (or $11\frac{1}{4}$). Thus the actual length of the embryo in figs. 124. 125. and 126. which measured $\frac{1}{7}$ of a Paris line, is found to have been about $\frac{1}{79}$ of an English inch.

When the object is not spherical, it is the long diameter, the measurement of which is given in the Table.

No. of Figure.	Diameters magnified.	Actual Diameters.					
		*bb*¹. Central portion of the Germ.	*bb*². Peripheral portion of the Germ.	Embryo *bb*¹. + *bb*².	Mulberry-like Structure.	Membrane *f*.	*Cho.* Chorion.
103 *a*	75	....	....	....	....	$\frac{1}{12}$	
104 *a*	75	....	....	....	....	....	$\frac{1}{12}$
105	75	....	....	....	....	....	$\frac{1}{10}$
$105\frac{1}{2}$	75	....	....	....	....	....	$\frac{1}{11}$
106	75	....	....	....	....	....	$\frac{1}{9}$
109	75	....	....	....	$\frac{1}{25}$	....	$\frac{1}{7}$
110	75	....	....	....	$\frac{1}{20}$	$\frac{1}{12}$	$\frac{1}{5}$
111	75	....	....	....	....	....	$\frac{1}{7}$
112	75	....	....	....	....	$\frac{1}{10}$	$\frac{1}{5}$ +
113	75	....	....	....	....	$\frac{1}{12}$	$\frac{1}{7}$
114	50	....	....	....	....	....	$\frac{1}{4}$ −
115	50	....	....	....	....	....	$\frac{1}{6}$
116	50	....	....	....	....	....	$\frac{1}{5}$
117	50	....	....	....	....	....	$\frac{1}{6}$
118	36	....	....	....	....	$\frac{1}{6}$	$\frac{1}{4}$
119	36	....	....	....	....	....	$\frac{1}{4}$ +
121 A	50	....	$\frac{1}{10}$	....	....	....	$\frac{2}{5}$
122	40	about $\frac{1}{4}$					
123	40	$\frac{1}{4}$					
124	40	....	....	$\frac{1}{7}$	....	....	$\frac{1}{3}$ −
125	120	....	....	$\frac{1}{7}$			
126	120	....	....	$\frac{1}{7}$			
153	75	....	....	....	....	....	about $\frac{1}{10}$

successors (Plate VI. figs. $105\frac{1}{2}$ to 108, &c.), is produced by myriads of minuter and epithelium-like "cells" with which they are filled, as will be shown in drawings on a larger scale to accompany a future paper.

321. Explanation of the Plates.

N.B. In all the figures the same letters denote the same objects; as may be seen by the explanation at the foot of each Plate. The same letters are used as in the "First Series."

b. Germinal spot.

bb. Germ.

bb^1. Central portion of the germ } Embryo.

bb^2. Peripheral portion of the germ—"tache embryonnaire" —"area vasculosa." } Embryo.

bb$^{2\prime}$. Future vascular lamina of the umbilical vesicle.

c. Germinal vesicle.

d. Yelk,—yelk-globules (vesicles),—escaped yelk.

e. Membrane originally investing the yelk—proper membrane of the yelk (which disappears. Compare in Plate VI. fig. 105. with fig. 105$\frac{1}{2}$.),—also yelk-ball.

f. Thick transparent membrane of the ovarian ovum—"zona pellucida."

f^1. Fluid imbibed by the chorion.

g. Peculiar granules (vesicles) of the ovisac.

g^1. Tunica granulosa.

g^2. Retinacula.

h. Ovisac.

i. Proper covering of the ovisac,—also *corpus luteum*.

hi. Graafian vesicle (consisting of *h* + *i*).

k. Stroma.

l. Peritoneum.

x. Nucleus—"cytoblast."

am. Amnion.

am.f. Union of the membranes *am*. and *f*.

a.p. Area pellucida.

cho. Chorion, becoming villous in the uterus—villous chorion.

cho^1. Villi.

PLATE V.

Fig. 81. Common Fowl (*Phasianus Gallus*, Linn.). A very early stage in the formation of the ovum (par. 242.).

Fig. 82. Rabbit (*Lepus Cuniculus*, Linn.). An extremely early stage in the formation of the ovum. Largest vesicle $\frac{1}{100}'''$ (par. 242.).

Fig. 83. Rabbit. A stage in the formation of the ovum rather more advanced than that in the preceding figure. Largest vesicle $\frac{1}{75}'''$ (par. 242.).

Fig. 84. Rabbit. The stage succeeding that in the last figure. Largest vesicle $\frac{1}{50}'''$. (par. 242.).

Fig. 84½. Frog (*Rana temporaria*, Linn.). Nucleus (x) on the inner surface of the vitellary membrane. h. The ovisac (par. 292.)

Fig. 85. Tiger (*Felis Tigris*, Linn.). An immature ovum (par. 120.) crushed to show the nature of the membrane f.

Fig. 86. Tiger. Part of a Graafian vesicle (hi) containing an ovum with its tunica granulosa (g^1) and retinacula (g^2). The germinal vesicle has become elliptical by maceration for a short time (par. 124.).

Fig. 87. Tiger. Vesicles of the yelk; the largest $\frac{1}{300}'''$. They contain vesicles in their interior (par. 121. 296.).

Fig. 88. Tiger. An ovum after maceration for a short time (par. 123, 124.). The membrane f has become distended, and it has imbibed fluid, which lies between that membrane and the proper membrane of the yelk (e). The germinal vesicle and germinal spot are altered by maceration. (See fig. 89.)

Fig. 89. Tiger. The germinal vesicle (c) and germinal spot (b) of the ovum in the last figure, more highly magnified, to show the effects of maceration for a short time. The germinal vesicle has become elliptical, and the germinal spot has resolved itself into several vesicles with intervening granules (par. 124. 299.).

Fig. 92. Rabbit. The germinal vesicle from a fecundated ovum. The vesicle though ruptured has not collapsed, owing to its now consisting of two membranes (par. 133.).

Fig. 93. Rabbit. An ovum from the ovary in the "first stage" of development. (par. 141.).

Fig. 94. Rabbit. The proper membrane of the yelk ($\frac{1}{20}'''$) from an ovum which seemed on the point of being discharged from the ovary. It has thickened (par. 136.).

Fig. 95. Rabbit. A Graafian vesicle 9¼ hours *post coitum*, about to discharge its ovum. The covering (i) of the ovisac is now a thick and highly vascular mass; it being this structure which becomes the corpus luteum (par. 152 to 157.).

Fig. 96. Rabbit. The same on a larger scale, and after being ruptured (par. 153.). This figure shows that the tunica granulosa (g^1) and retinacula (g^2) are discharged with the ovum (par. 150.). The ovum is in the "second stage" of development (par. 141.).

Fig. 97. Rabbit. The same ovum on a larger scale. It is in the "second stage" of development (par. 141.).

Fig. 98. Rabbit. The ovisac as obtained, free from its covering, a few hours after the expulsion of the ovum from the ovary. It presents the orifice ($\frac{1}{4}'''$ in length) through which the ovum escaped (par. 154.).

Fig. 99. Hog (*Sus Scrofa*, Linn.). An ovum in which are seen the effects of incipient absorption *post coitum* (par. 158 to 160.). The yelk (*d*) is becoming fluid, a change which takes place first around the germinal vesicle (par. 159.). Dark globules are seen on the surface of the ovum.

Fig. 100. Hog. An ovum in which absorption (*post coitum*) has proceeded farther than in the last figure. The ovum has become elliptical (par. 158 to 160.).

Fig. 101. Rabbit. An ovisac (found in the ovary *post coitum*) apparently about to be absorbed. The ovum, and the germinal vesicle (*c*) have become elliptical, and the yelk (*d*) is in the state of fluid (par. 158 to 160.).

Fig. 102. Hog. An ovisac found in the infundibulum, apparently in the course of being absorbed (par. 162 to 165. 297.).

PLATE VI.

Fig. 103. Rabbit. α. An ovum of ten hours, and measuring in diameter $\frac{1}{12}'''$, found in the Fallopian tube, at the distance of an inch from the infundibulum. It is in the "third stage" of development (par. 170.). β. The same ovum crushed, to show the strength of the proper membrane of the yelk (*e*), which is unbroken and still contains the yelk, though forced through the ruptured membrane *f*. (par. 171.).

Fig. 104. Rabbit. α. An ovum of forty-one hours, and measuring in diameter $\frac{1}{12}'''$, found about an inch from the infundibulum in the Fallopian tube. It is in the "fourth stage" of development. The chorion (*cho.*) is visible, and closely invests the membrane *f*. β. Another ovum of the same Rabbit found further advanced into the tube. It has been crushed, and shows the chorion (*cho.*) now separated from the membrane *f*. (par. 172.).

Fig. 105. Rabbit. An ovum of $35\frac{3}{4}$ hours, and measuring in diameter $\frac{1}{10}'''$, found in the Fallopian tube near its middle. It is in the "fifth stage" of development (par. 173.).

Fig. $105\frac{1}{2}$. Rabbit. An ovum of twenty-four hours, and measuring in diameter $\frac{1}{11}'''$, found in the Fallopian tube at its middle part. It is in a state between that represented in fig. 105 and that in fig. 106. (par. 174. *Note*, 315. 316.)

Fig. 106. Rabbit. An ovum of $35\frac{3}{4}$ hours, and measuring in diameter $\frac{1}{9}'''$, found with the ovum represented in fig. 105. It is in the "sixth stage" of development (par. 174.).

Fig. 107. Rabbit. Vesicles in the centre of an ovum somewhat larger than that in the preceding figure, found in the Fallopian tube. These vesicles are smaller and more numerous than those in the last stage, and larger and less numerous than those in the stage following. They represent the "seventh stage" of development (par. 175. 317.).

Fig. 108. Rabbit. Vesicles in the centre of an ovum from the Fallopian tube, representing the "eighth stage" of development (par. 176. 317.).

Fig. 109. Rabbit. An ovum of sixty-three hours, and measuring in diameter $\frac{1}{7}'''$, found in the Fallopian tube, within about an inch of the uterus. It is in the "ninth stage" of development (par. 178.).

Fig. 110. Rabbit. An ovum of $68\frac{3}{4}$ hours, and measuring in diameter $\frac{1}{5}'''$, found in the Fallopian tube within $\frac{3}{4}$ inch of the uterus. It is in the "tenth stage" of development (par. 180.).

Fig. 111. Rabbit. An ovum of $79\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{7}'''$, found in the uterus near the Fallopian tube. It is in the "eleventh stage" of development (par. 184.).

Fig. 112. Rabbit. An ovum of eighty-six hours, and measuring in diameter $\frac{1}{5}'''+$, found in the uterus within an inch of the Fallopian tube. It is in the "twelfth stage" of development (par. 185.).

Fig. 113. Rabbit. An ovum of $102\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{7}'''$, found in the uterus near its middle. It is in the "thirteenth stage" of development (par. 186. 187.).

Fig. 114. Rabbit. An ovum of 105 hours, and measuring in diameter $\frac{1}{4}'''$, found in the uterus $\frac{3}{4}$ inch from the Fallopian tube. It is in the "fourteenth stage" of development (par. 189.).

Fig. 115. Rabbit. An ovum of $94\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{6}'''$, found in the uterus near the Fallopian tube. It is in the "fifteenth stage" of development (par. 190. 191.).

Fig. 116. Rabbit. An ovum of $97\frac{3}{4}$ hours, and measuring in diameter $\frac{1}{5}'''$, found in the uterus about an inch from the Fallopian tube. It is in the "sixteenth stage" of development (par. 192.).

Fig. 117. Rabbit. An ovum of $97\frac{3}{4}$ hours, and measuring in diameter $\frac{1}{6}'''$, found in the uterus. It is in the "seventeenth stage" of development (par. 193 to 196.).

PLATE VII.

Fig. 118. Rabbit. An ovum of ninety-five hours, and measuring in diameter $\frac{1}{4}'''$, found in the uterus an inch from the Fallopian tube. It is in the "eighteenth stage" of development (par. 197 to 200.).

Fig. 119. Rabbit. An ovum of $108\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{4}'''+$, found in the uterus near the Fallopian tube. It is in the "nineteenth stage" of development (par. 201.).

Fig. 120. Rabbit. A portion of the future umbilical vesicle in an ovum of $107\frac{1}{2}$ hours, and measuring $\frac{2}{5}'''$, found in the uterus $1\frac{3}{4}$ inch from the Fallopian tube. It represents the "twentieth stage" of development (par. 202.).

Fig. 121. Rabbit. A portion of the future umbilical vesicle in an ovum of $111\frac{1}{2}$ hours, and measuring in diameter $\frac{2}{5}'''$, found in the uterus an inch from the Fallopian tube. It represents the "twenty-first stage" of development (par. 203.).

Fig. 121 A. Rabbit. An ovum of $111\frac{1}{2}$ hours, and measuring in diameter $\frac{2}{5}'''$, found in the uterus an inch from the Fallopian tube (par. 205. 206.). Drawn as seen lying in kreosote water (par. 239.). The embryo is described in pars. 209. and 212 to 215.

Fig. 121 B. Rabbit. The embryo (*bb*[1] and *bb*[2].) and incipient amnion (*am.*). The embryo is in a stage succeeding that in fig. 121 A (par. 212 to 215.).

Fig. 121 C. Rabbit. The most central portion of the embryo in fig. 121 B, on a larger scale (pars. 213. 214.).

Fig. 121 D. Rabbit. The central portion (*bb*[1]) of the germ, from an ovum of 103 hours, and measuring in diameter $\frac{1}{5}'''$. *am. f.* Union of the membranes *am.* and *f.*

Fig. 122. Rabbit. The embryo (*bb*[1] + *bb*[2]) and incipient amnion (*am.*) from an ovum of $124\frac{1}{4}$ hours, and measuring in diameter $1''' +$, found in the uterus (pars. 214 to 216.).

Fig. 123. Rabbit. The central portion of the germ ($\frac{1}{4}'''$ in length) (par. 215.) from an ovum of $164\frac{1}{2}$ hours, and measuring in diameter more than $2\frac{1}{4}'''$, found in the uterus. This figure presents an instance of size being in advance of development (pars. 167. 218.).

Fig. 124. Rabbit. An ovum of $115\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{3}'''$, found in the uterus. The embryo (*bb*[1]) measured in this instance only $\frac{1}{7}'''$ (= $\frac{1}{79}$ of an English inch), thus presenting an example of development being greatly in advance of size (pars. 167. 218.).

Fig. 125. Rabbit. The embryo from the last figure, more highly magnified. It exhibits a tendency to become curved at the cephalic end, and transverse wrinkles, thereby produced (par. 219.).

Fig. 126. Rabbit. The same, as seen after slight pressure had been applied (par. 219.).

Fig. 127. Rabbit. The visceral surface of the foundation of the central portion of the nervous system and vertebræ in an embryo of rather less than $1\frac{1}{2}'''$, from an ovum of $8\frac{1}{2}$ days, and measuring in diameter $6''' +$, found in the uterus (par. 217.).

PLATE VIII.

Fig. 128. Rabbit. The ovum of Plate VI. fig. 109, after being crushed. The dotted line denotes the inner surface of the subsequently villous chorion (*cho.*) (par. 178.).

Fig. 129. Rabbit. Vesicles of the future amnion, from an ovum of $94\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{5}'''$, found at the junction of the uterus and Fallopian tube (par. 190.).

Fig. 130. Rabbit. An ovum resembling that in Plate VI. fig. 110, after being crushed (par. 180.). The dotted line denotes the inner surface of the subsequently villous chorion (*cho.*) (par. 178.). Compare this ovum with fig. 131. from *Unio tumida* (par. 243.).

Fig. 131. From Carus. An ovum from the gills of *Unio tumida*. Compare with fig. 130. from the Rabbit (par. 243.).

Fig. 132. Rabbit. A portion of the network of which the subsequently vascular lamina of the umbilical vesicle consists in the "nineteenth stage" of development (Plate VI. fig. 119.) (par. 201.).

Fig. 133. Rabbit. An aborted ovum, found in the uterus (par. 226.).

Fig. 134. Rabbit. An aborted ovum, found in the uterus (par. 226.).

Fig. 135. Rabbit. An aborted ovum, found in the uterus (par. 226.).

Fig. 136. Rabbit. A vesicle, found in the Fallopian tube with others of the same kind (par. 227.).

Fig. 137. Rabbit. An ovum of $162\frac{3}{4}$ hours, and measuring in diameter $\frac{7}{10}'''$, found in the uterus. It is in a collapsed state from the effects of water (par. 231.).

Fig. 138. Rabbit. An ovum of $\frac{9}{10}'''$, drawn after lying three days in kreosote water (par. 239.).

Fig. 139. Rabbit. An ovum of $\frac{3}{4}'''$, drawn after lying four days in tar water (par. 241.).

Fig. 140. Rabbit. An ovum of $\frac{1}{4}'''$, showing the effects of nitrate of silver (par. 238.). The objects presenting in this ovum the appearance of a network, are vesicles such as those in Plate VIII. fig. 150.

Fig. 141. Rabbit. Villous tuft, measuring in diameter $\frac{1}{50}'''$, as seen on the chorion of an ovum from the uterus, measuring $\frac{7}{10}'''$ (par. 223.).

Fig. 142. Rabbit. Villous tufts seen in profile on the chorion (*cho.*) of an ovum from the uterus, measuring in diameter $\frac{7}{10}'''$ (par. 223.).

Fig. 143. Rabbit. An ovum of 23 hours, and measuring in diameter $\frac{1}{12}'''$, found in the Fallopian tube (par. 306.).

Fig. 144. Rabbit. An aborted ovum of $115\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{11}'''$, found in the uterus (par. 308. and *Note.* 317. *Note.*). It is in a state which, in reference to the central portion of the ovum, is between that represented in Plate VI. fig. 105. and that in fig. $105\frac{1}{2}$.

Fig. 145. Rabbit. An ovum of $114\frac{1}{4}$ hours, and measuring in diameter $\frac{1}{2}'''$, found in the uterus. The membrane *am.* is adherent at a certain part to (*f*) the thick transparent membrane of the ovarian ovum (pars. 206. 208.). Drawn after lying six weeks in dilute spirit (par. 233.).

Fig. 148. Rabbit. The germ in its vesicle, as seen within the (imperfectly formed) mulberry-like structure while still in the centre of the ovum. The incipient separation of the germ into a central (bb^1) and a peripheral (bb^2) portion appeared to have bcen premature (par. 193. *Note*).

Fig. 149. Rabbit. Vesicles of which the incipient embryo was composed, in an ovum of $111\frac{1}{2}$ hours, and measuring in diameter $\frac{2}{5}'''$, found in the uterus an inch from the Fallopian tube (par. 301. 305.). Drawn after lying 48 hours in kreosote water (par. 239.).

Fig. 150. Rabbit. Vesicles of the outer and subsequently vascular lamina of the umbilical vesicle, from an ovum of $107\frac{1}{2}$ hours, and measuring in diameter $\frac{2}{5}''' +$, found in the uterus near the Fallopian tube (par. 211.). The interior of these vesicles was brought into view by nitrate of silver (par. 238.).

PLATE IX.

Fig. 151. Rabbit. A vesicle found under the mucous membrane at the junction of the uterus and Fallopian tube. The mulberry-like object in its centre was observed for half an hour to perform rotatory motions (pars. 282 to 287.).

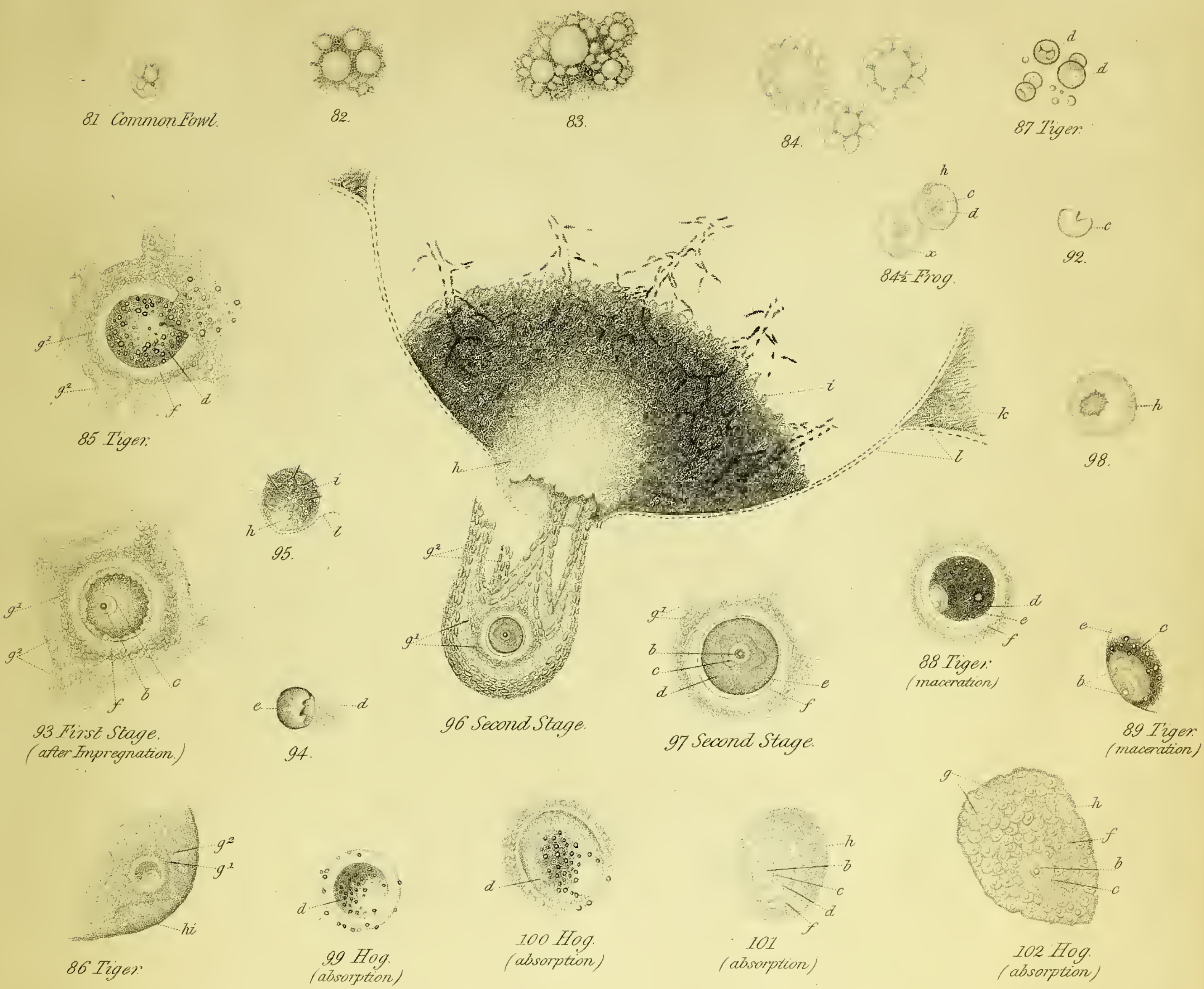
Fig. 152. Rabbit. Vesicles from the surfacc of the mulberry-like object found in vesicles such as the onc in fig. 151. (par. 285.)

Fig. 153. Rabbit. An ovum of 17 hours, and measuring in diameter about $\frac{1}{10}'''$, found in thc Fallopian tube near its middle (par. 173. *Note*. 221. to 225.).

Fig. 154. Rabbit. Vcsicles found in a cream-white substance, filling to distention the left uterus, $157\frac{3}{4}$ *post coitum*. This substance—at first of about the same consistence as pus—coagulated very shortly after the uterus had becn laid open. Thc vesicles varied in size from $\frac{1}{200}'''$ to $\frac{1}{300}'''$, most of them measuring about $\frac{1}{250}'''$.

Fig. 155. Rabbit. Two vesicles from the centre of an ovum of $26\frac{1}{4}$ hours, and measuring in diameter about $\frac{1}{10}'''$, found in the Fallopian tube on the ovarian side of its middle part. This figure represents a condition of the ovum between that in Plate VI. fig. $105\frac{1}{2}$, and that in fig. 106 (par. 317.).

Embryology.



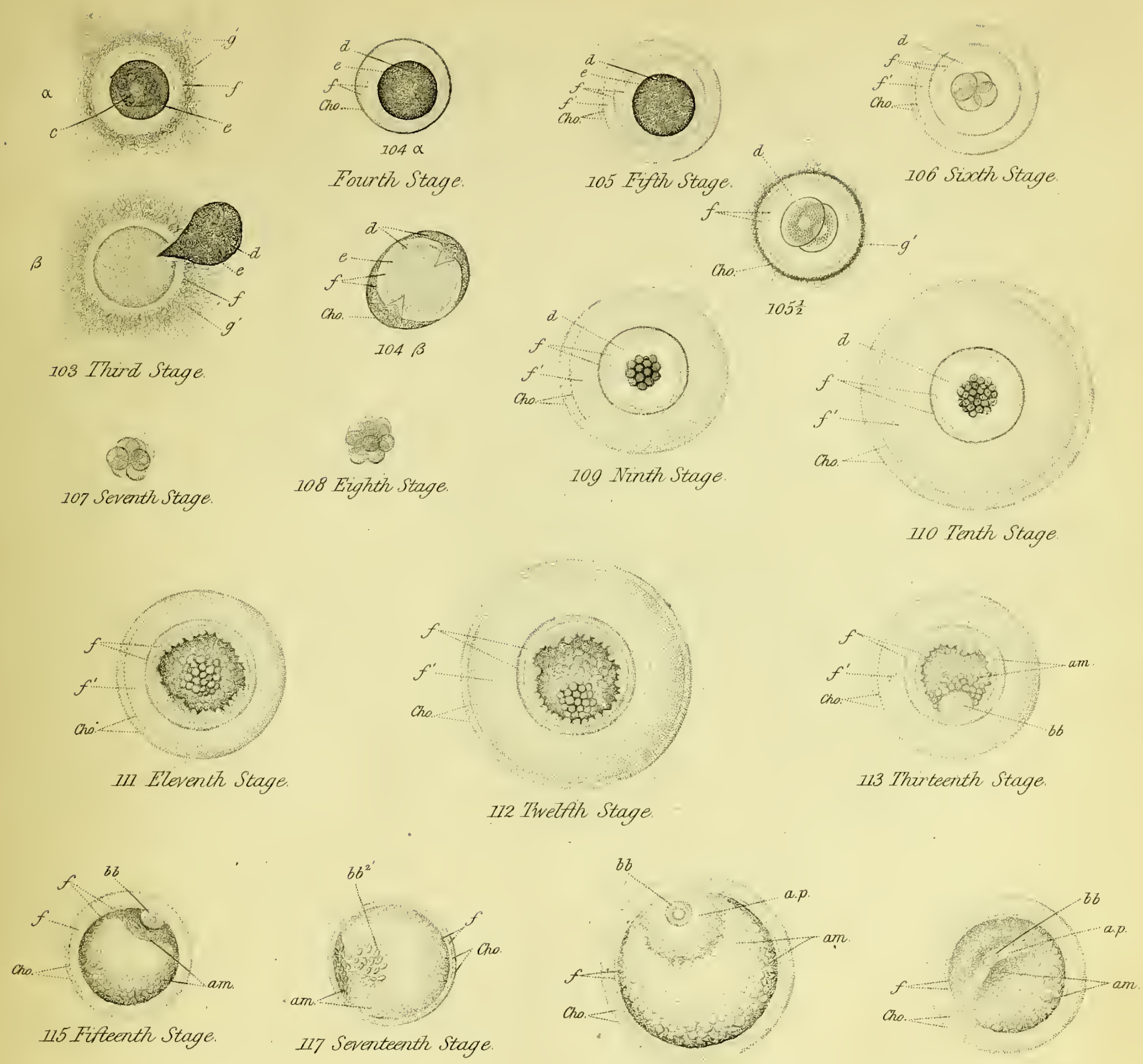
(Where the name of the animal is not given the Figure is from the Rabbit.)

b. Germinal Spot
c. Germinal Vesicle
d. Yelk.—Yelk-globules (vesicles)
e. Membrane originally investing the Yelk—Yelk-ball
f. Thick transparent membrane of the ovarian Ovum "Zona pellucida".
g. Peculiar Granules (vesicles) of the Ovisac
g^1 Tunica granulosa
g^2 Retinacula
h. Ovisac
i. Proper covering of the Ovisac—Corpus luteum
hi. Graafian vesicle
k. Stroma
l. Peritoneum
x. Nucleus

Ad Nat. del. Martin Barry.

J. Basire sc.

Embryology.



103 Third Stage. — *104 α Fourth Stage.* — *104 β* — *105 Fifth Stage.* — *105½* — *106 Sixth Stage.* — *107 Seventh Stage.* — *108 Eighth Stage.* — *109 Ninth Stage.* — *110 Tenth Stage.* — *111 Eleventh Stage.* — *112 Twelfth Stage.* — *113 Thirteenth Stage.* — *114 Fourteenth Stage.* — *115 Fifteenth Stage.* — *116 Sixteenth Stage.* — *117 Seventeenth Stage.*

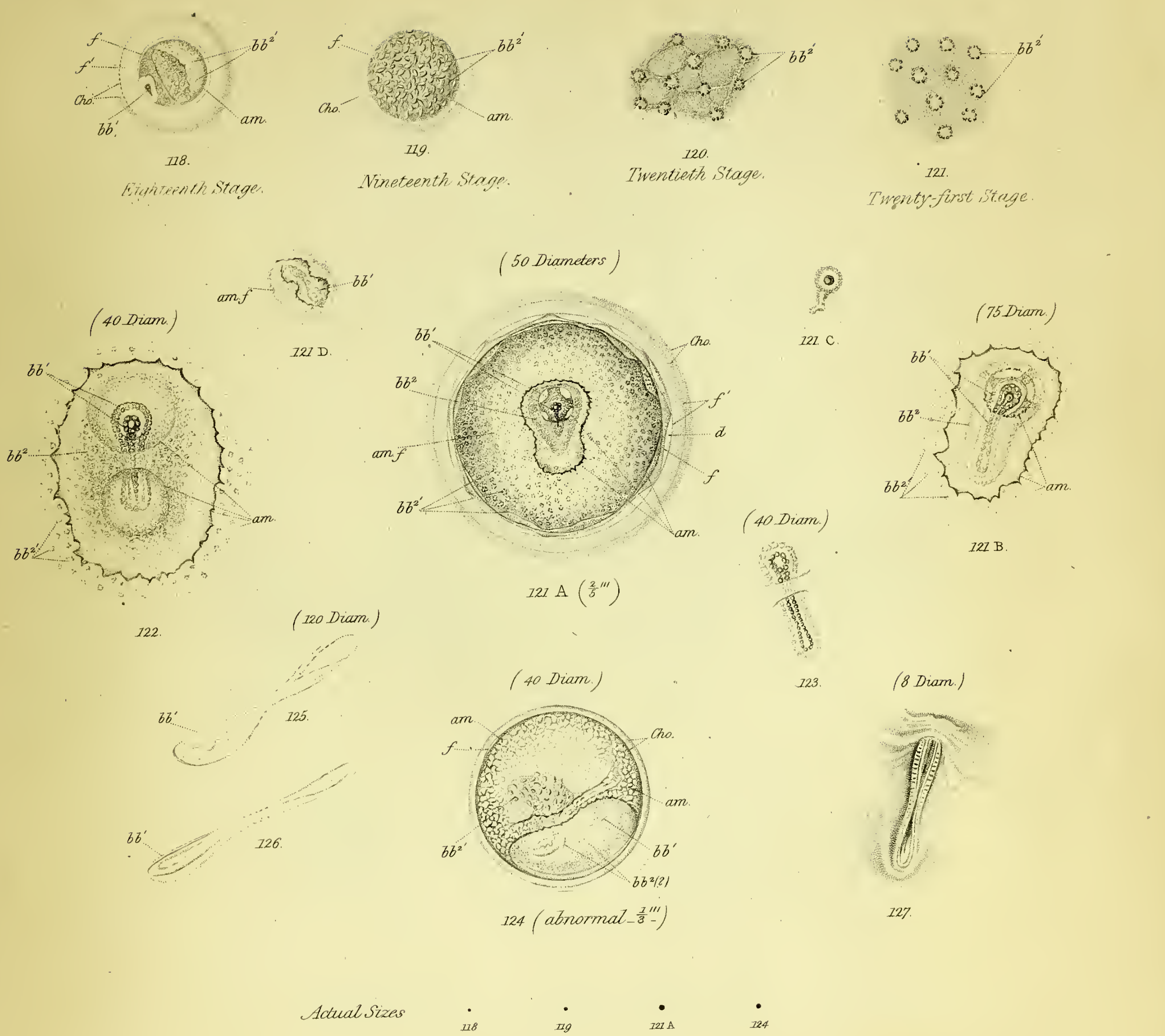
Actual Sizes 103 104 105 109 110 111 112 113 115 117 114 116

(All the Figures represent Ova of the Rabbit; _ in Figs 103 to 113 _ magnified 75 diameters; in Figs 114 to 117 _ 50 diam.)

bb. The true Germ
bb². Future Vascular Lamina of the Umbilical Vesicle
c. Germinal Vesicle
d. Yelk
e. Membrane originally investing the Yelk
f. Thick transparent membrane of the ovarian Ovum _ "Zona pellucida"
f′. Fluid imbibed by the Chorion
g′. Tunica granulosa
Cho. Chorion, subsequently villous
am. Amnion
a.p. Area pellucida

Nat. del. Martin Barry. — *Js Basire, sc.*

Embryology.



(All the Figures are from Ova of the Rabbit)

bb′. Central Portion of the Germ

bb². Peripheral Portion of the Germ

bb²′. Lamina subsequently vascular

d. Escaped Yelk

f. Thick transparent membrane; "Zona pellucida"

f′. Fluid imbibed by the Chorion

Cho. Chorion, subsequently villous

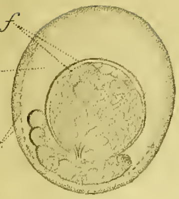
am. Amnion

am.f Union of the membranes *am.* and *f.*

Ad Nat. del. Martin Barry.

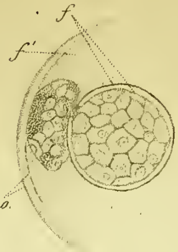
J. Basire, sc.

Embryology.



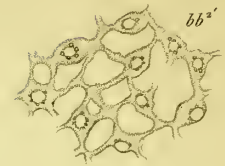
128.

129.
Amnion.

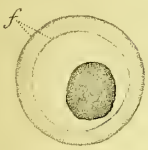


130.


131.
Fresh Water Mussel.
(from Carus)

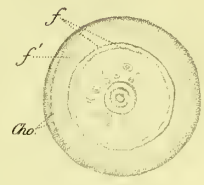


132.

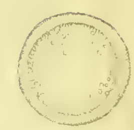


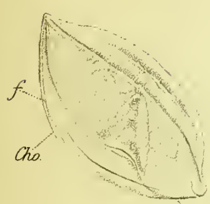
133.
Aborted.

134.
Aborted.

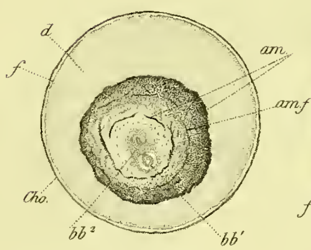


135.
Aborted.

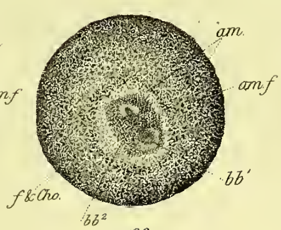

136.



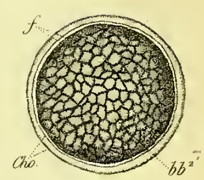
137.
(Water)



138.
(Kreosote Water.)



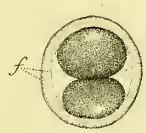
139.
(Tar Water)



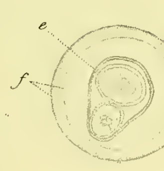
140.
(Nitrate of Silver.)

142.

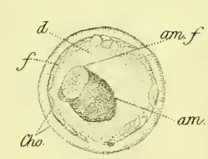
141.



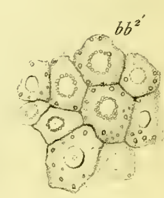
143.



144.



145.



150.


149.

148.

(All the Figures are from the Rabbit except Fig. 131.)

bb'. Central Portion of the Germ

bb². Peripheral Portion of the Germ

bb²' Future vascular Lamina of the Umbilical Vesicle

d. Yelk _ Escaped Yelk

f. Thick transparent membrane of the ovarian Ovum _ "Zona pellucida"

f'. Fluid imbibed by the Chorion

Cho. Chorion subsequently villous _ Villous Chorion

Cho'. Villi

am. Amnion

am.f Union of the membranes am. and f.

Ad Nat. del. Martin Barry.

J. Basire. sc.

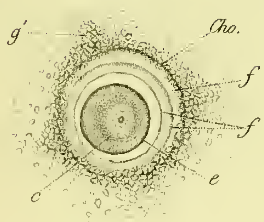
Embryology.

154.

151.

Vesicle; — the mulberry-like object in the centre revolving on its own axis. (About 120 Diameters.)

155.



153.

An Ovum of 17 hours from the middle of the Fallopian Tube, showing the mode of origin of the Chorion (Cho.). This membrane is rising from the thick transparent membrane or "Zona pellucida" (f), surrounded by part of the Tunica granulosa (g′). (See also Pl. VI fig. 105½, representing an Ovum in which the Chorion (Cho.) was on all sides equidistant from the membrane f.) (75 Diameters.)

152.

Vesicles from the surface of the mulberry-like object in Fig. 151.

(The three Figures are from the Rabbit.)

c. Germinal Vesicle

e. Yelk-Ball.

f. Thick transparent membrane of the ovarian Ovum — "Zona pellucida".

f′. Fluid imbibed by the Chorion

g′. Tunica granulosa

Cho. Chorion, subsequently villous.

Ad Nat. del. Martin Barry. J^s Basire. sc.